STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME
BUREAU OF MARINE FISHERIES

Fish Bulletin No. 72

Trawling Gear in California

By W. L. SCOFIELD

1948

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CONTENTS

	Page
Foreword	5
Trawling Success	7
Types of Trawls	8
Definitions	9
Trawl	9
Otter Board	9
Head Rope and Foot Rope	9
Bridle	10
Warp	10
Spreader	10
Cod End	10
Ground Cable	10
Take Up	11
Mesh Size	11
Development of Trawls	13
Dredge	14
Beam	14
Paranzella	16
Otter	18
V-D	19
N. E.	19
Balloon	20
Kiska	20
1947	21
The Paranzella	22
Introduction of the Paranzella	22
Steam Tugs	22
Gasoline Boats	23
Paranzella Fishery	23
1915	23
1924	24
1934	25
Introduction of Otter Trawls	30
Italian Nets	33
San Francisco 1947	33
Southern California	36
Box Nets	38
Eastern Nets	41

CONTENTS—Continued

	Page
Balloon Nets	44
California Beam Trawl	46
Operations in General	47
Warp-Depth Ratio	47
Trips, Ice, Cleaning	47
Shooting the Net	48
Hauling the Net	48
Landing the Net	48
Splitting Strap vs. Brailing	48
Size of Catch	49
Number of Boats	50
Savings Gear	51
Accessory Gear	51
Boards	51
Gallows	52
Depth Finders, Radio Telephones, Direction Finders	52
Dandyline	53
Choo-choo Line	54
Haulback Line	55
Snag Line	55
Legislation	56
References	59

FOREWORD

The purpose of this publication is to describe trawling gear used in California and to give an account of the development of the fishery in the hope that it may prove helpful in future studies of trawler catches. Most of the material was prepared for publication in 1947.

In the preparation of these pages we were given assistance by many men in the fish trade but we are especially grateful to the skippers of trawler vessels who so patiently answered the innumerable questions that only a persistent novice would ever think of asking.

W. L. Scofield
June, 1948

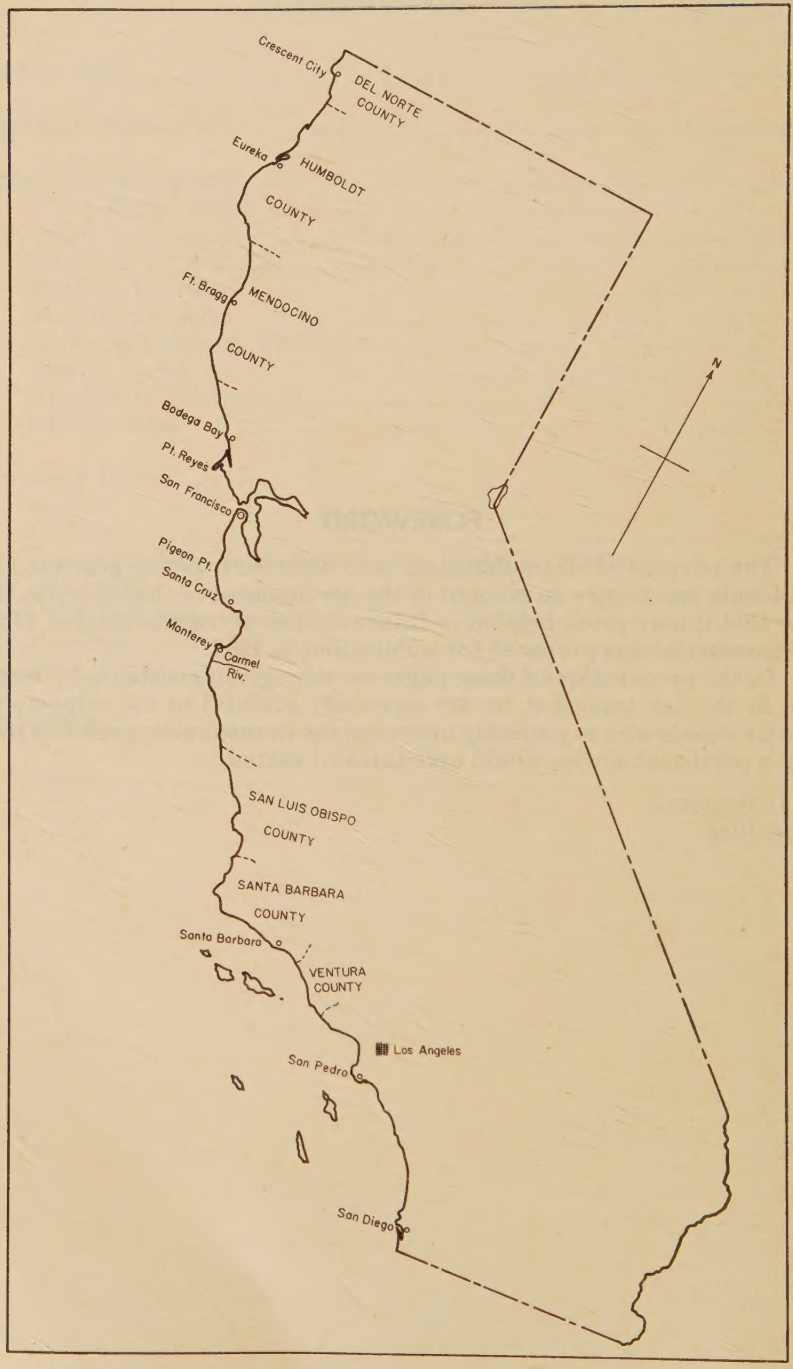

FIGURE 1. Outline map of California, showing location of fishing ports

TRAWLING GEAR IN CALIFORNIA

By W. L. SCOFIELD

TRAWLING SUCCESS

The name trawl is derived from the manner of operating the net rather than from any peculiarity of the net itself. The net is essentially a flattened bag which is towed or trawled over the ocean floor and this manner of fishing has shown itself to be very efficient in taking deep water fishes in large quantity at low operating cost. The capture of demersel fishes by means of hand lines, set or long lines and submerged gill or trammel nets requires more men, working longer hours for a smaller catch than does the dragging of a bag net along the ocean bottom. The other methods of fishing cannot compete successfully with trawling, hence the hatred of trawling through the years and the bitter denunciations heaped upon the trawl. Much of the criticism of the trawl was justified because the small mesh of the drag nets picked up vast quantities of small and unmarketable fish which were wasted. Some accusations, born of hatred, were not true, for example, the persistent claim that trawling destroyed fish spawn and thus ruined an area for any future fishing.

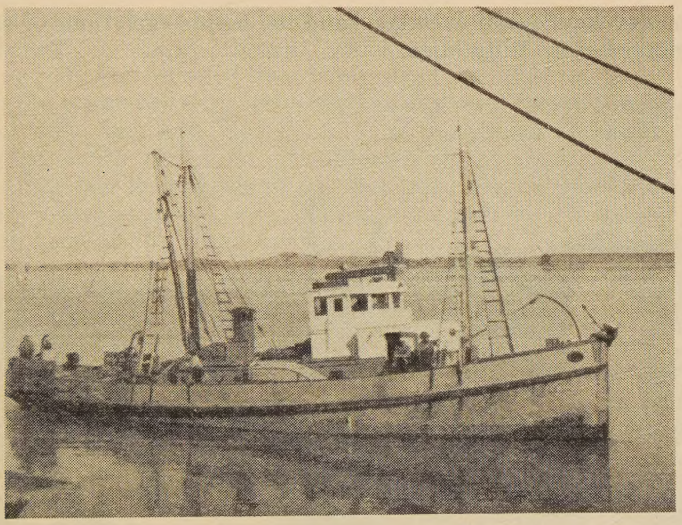

FIGURE 2. The *Catherine Paladini*, a typical San Francisco paranzella dragger, based later at Eureka and still later converted to otter trawling. *Photograph by W. E. Ripley at Eureka, May 23, 1946*

Another factor contributed to the success of trawling as a method of fishing. The dragging of a deeply submerged net could be continued after the weather became too rough to permit fishing operations by setliners or trammel netters. Trawling vessels averaged larger than set line boats and put to sea in weather that kept smaller craft port bound. Thus in spells

of bad weather it frequently happened that no fish was delivered except the trawl-caught fares which benefited from any upward price fluctuation due to bad-weather scarcity of fish. However, trawling was not dependent upon favorable sale price. Quite the contrary, trawling was profitable at low price because of the quantity production at low operating cost. Consequently price to small-boat fishermen usually sagged when trawlers operated in an area. This pinched the small operators and often drove them into some other type of fishing. It is little wonder that trawlers have been condemned by small-scale fishermen.

TYPES OF TRAWLS

Although there are many variations in the construction of trawl nets, there are three basic types determined by the device employed to keep the mouth of the bag open. The simplest method is to attach the net to a rigid horizontal pole or beam. This is the beam trawl.

Another method is to employ two towing lines, each line towed by a separate vessel. The two vessels follow parallel courses but at sufficient distance apart so that the diverging tow lines pull outward and keep the net mouth spread open. This is the two-boat or paranzella type.

The outward pull on the net mouth may be accomplished by a pair of kite-like boards, one at each side of the net, so hung at an angle that the boards tend to diverge or kite outward which keeps the mouth of the net open. This is the otter trawl.

The development of each type and the major variations of each will be considered more fully later.

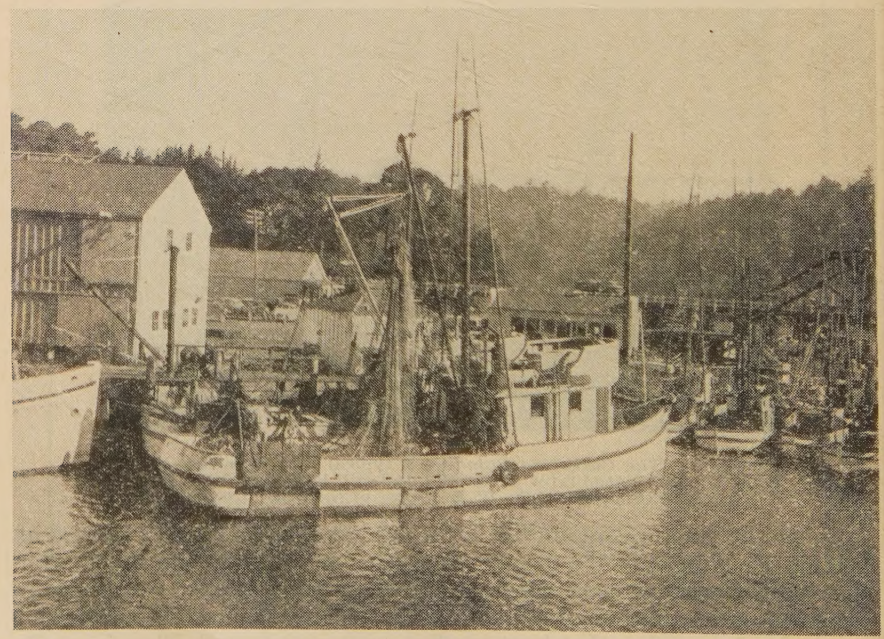

FIGURE 3. A modern purse seine type vessel operating a balloon otter trawl. Based at Noyo (Fort Bragg). *Photograph by J. B. Phillips, November 18, 1947*

DEFINITIONS

Terminology among the west coast trawlers has not become standardized so that some confusion results from using several names for one part of the gear and conversely one term may have three or four applications. Words from one of the Scandinavian languages and Italian names are commonly used but in this account of gear we have attempted to avoid foreign language names where possible.

Trawl

A trawl is a drag net. It is a large bag net, tapering aft from the mouth, forming a flattened cone, with some device for keeping the mouth of the net open while it is towed or dragged over the sea bottom. It is used for catching demersal fishes at some distance from shore in moderately deep water. Dragging such a net is trawling and the men or boats that trawl are trawlers. The term as applied by east coast fishermen to their set lines is an unfortunate use of the word because fixed or stationary gear cannot wander, that is, cannot trawl.

Troll is a word of similar sound and origin to the word trawl but quite different in meaning. As a verb, troll means literally to ramble or wander and in fishing it is the pulling of a line with one or more hooks through the water not far under the water surface and usually behind a moving boat.

Otter Board

Many trawl nets have a board called "door," "sheer board," "otter board" or simply "board" which is hung from four bridle lines, chains, or rods, the forward lines being shorter so that the board is at an angle to the water pressure when the board moves forward thus causing it to veer off to one side, diverge, kite out or spread. The board is used to keep the mouth of the net open. Boards are of many shapes, usually four to eight feet long, three to five feet high, two or three inches thick and heavily strapped with iron, with the greatest weight on the bottom to help in keeping the board upright.

Head Rope and Foot Rope

In most nets the upper edge of the webbing is hung from a rope called head rope, head line, or cork line. Usually the head rope carries corks or floats to give buoyancy to the net. In bag nets or trawls the upper edge of the mouth or opening to the bag is supported by a head rope, usually (but not always) floated by corks or balls of glass or metal. In deep water trawling, cork is useless as a float because it becomes waterlogged when the pressure drives sea water into the pores of the cork.

The lower edge of net webbing is usually attached to a rope called foot rope, ground rope, or lead line which usually (not always) carries lead weights to stretch the webbing downward from the head rope. In trawls the foot rope is the lower edge of the net mouth, usually scraping over the sea bottom. When speaking of trawls there may be confusion in using the two terms "ground rope" and "ground cable" for the foot rope because these terms are used also for the wire rope from board to net in the V-D trawl and its variations.

Bridle

Literally to bridle is to restrain or curb. In trawling, the term usually (but not always) is applied to short supporting lines intended to hold some rigid object in position. In flying a kite the four strings attaching the kite to the main cord are bridle strings and the four chains or iron bars that hold an otter board at the proper angle when attached to the towing warp are the bridles. Short lines attaching the board to its ground cable are bridles. The longer lines from otter board to net wing are sometimes called bridles. In the beam trawl the lines from each trawler-head to the warp are bridles. The spreader at the end of a net wing is held in position by short bridles. Another use of the term applies to the fore and aft lines run down the sides, top or belly of a trawl net to strengthen the net by taking up part of the strain while fishing. These are also called rib lines.

Warp

In trawling, a warp is a tow line, the line by which the vessel drags the net along the ocean floor.

Spreader

In some types of trawls, the outer end of a net wing terminates in a two-foot stick or short stake, used to keep the wing stretched vertically or spread, hence spreader (Fig. 6). The old term "brail" is sometimes used. California fishermen seldom use the name "dhanleno" which was the name of a famous tight rope walker in England. When the V-D trawl first appeared, the spreaders were called "grandineaux" but the English fishermen called them Dan Lenos. Frequently the spreader is called "the stick."

Cod End

The tapering bag of a trawl net terminates in a short section, relatively narrow, of heavy construction and small mesh where the catch is concentrated while the net fishes. From the early days of beam trawling, this section has been called the cod end. The term "purse" is occasionally used, especially when the section can be opened by releasing a purse rope that cinches up purse rings. The purse rope is sometimes called "trip-line." Other cod ends may be opened to release the catch of fish by loosening a rope lacing that runs down the back of the cod end section. Often there are two openings, purse rings across the end and lacing along the back. Italian fishermen call the cod end a sack but their use of "sack" is loose and sometimes applies to all of the tapering portion of the net back of the wings.

Ground Cable

In early otter trawls, the end of the wing of the net was lashed directly to the otter board. The first modification was to extend the head and foot ropes about six feet beyond the end of the wing before attaching them to the board. This was to allow seaweed and other trash to escape before being picked up by the wing of the net. These six-foot extensions were called "legs" in England. An occasional fisherman on our coast now uses the term leg-line or door-leg-line. Later the board was placed far in advance of the wing, as in the V-D, N. E. and balloon trawls (Fig. 7). The "connecting cables" between board and wing have been

given a confusing variety of names. No one name can be considered as standard. In early V-D trawls the terms bridle or ground rope were used. "Ground cable" is frequently used but has the objection that the foot rope of a trawl is commonly called "ground line" or "ground cable." Ground warp is a name occasionally used but is awkward when there are two cables from each board. The term "sweep" is rarely used. The most frequently used name in California is "tow line" but this is objectionable because the towing warp so frequently is called tow line. Other fishermen use the much abused term "leader." In the N. E. type of gear, double lines to the wing are called "leaders" but more logically could be called long bridles. The Italians use the term "musetti" for the single line to the wing. Scandinavian words are in use but there is no distinctive English name in common use. Leg line might be a good name to adopt but it is rarely used at present. For want of a better name we have used "ground cable" for single lines and "tow lines" for the double lines from board to wing, in spite of the fact that tow line is commonly used for "warp."

Take Up

There are three methods of effecting a taper in the webbing of a net. Pieces of webbing, each of a somewhat smaller mesh size may be added, mesh for mesh, at the seam. This is rarely done. A second method is to cut the webbing on a diagonal. The web may be cut one horizontal for one vertical mesh, that is, one for one, or two for one, three for one, etc. This is done in trawl construction more frequently than in other types of nets.

The most frequently used method is to increase or decrease the number of meshes when hanging one piece to another. For example, every third mesh of the piece added may be laced to two meshes of the upper piece, thus reducing fullness at the ratio of four meshes to three. Our fishermen do not use the English term creasing for increasing or the terms stealing or bating (abating) for decreasing the number of meshes. They use "take up" or "taking in" for either operation.

Pieces laced or sewed together are "hung." Often there is a selvage or reinforcing of extra lacing, or a strip of heavy webbing or hand woven meshes is introduced as selvage. Skillful hanging uses the take up of meshes to gain the degree of fullness or taper desired when the net fishes.

MESH SIZE

A mesh of a net is one of the openings or spaces enclosed by the knotted cords forming the fabric of the net. In California, mesh size is measured as the distance between two diagonally opposite knots of a mesh when the mesh is pulled tight shut from these two knots. Thus a two-inch mesh (stretched measure) opens up into a square one inch on each of the four sides (Fig. 4). This open mesh in a net is usually hung diagonally so that it appears as a diamond rather than as a square. In this case the distance between the diagonally opposite knots of a fully opened two-inch mesh is approximately one and four-tenths inches. This has a bearing upon net length or depth because over-all measurement usually depends upon the degree to which the meshes are opened. For example, a net of two-inch mesh that is 100 meshes deep would measure roughly 200 inches deep if pulled vertically till the meshes closed but if

pulled horizontally the depth would be about a dozen inches (100 times the depth of one knot). If the same net hung with each mesh squarely open the depth would be 140 inches (100 times 1.4). This means that net

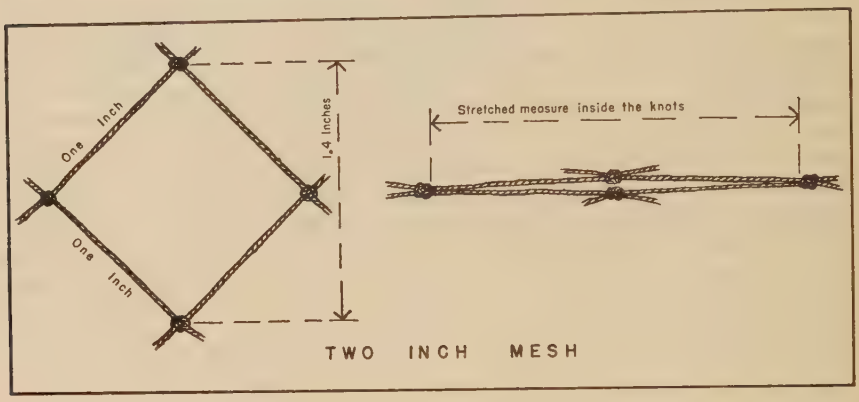

FIGURE 4. A two-inch mesh, open and stretched

measurements of length or depth are generally only rough approximations and the reader is to accept such measurements with mental reservations. Fishermen side-step complications by figuring net measurements in number of meshes. Then if you know the mesh size you can amuse yourself calculating over-all size if meshes hang squarely open, which they seldom if ever do, either ashore or while fishing.

Beginning in 1883, California law has provided that the stretched measure of a mesh shall be taken inside the knots. This is the logical method because it accurately measures the escapement size of the mesh, that is, the size at which a small fish of a certain size can pass through or the size at which fish of a definite size will gill. In some other states it is common practice for fishermen and supply houses handling machine woven webbing to measure the size of a stretched mesh as the distance from the center of the first knot to the center of the diagonally opposite knot. This is the same distance as from inside the first knot to outside the opposite knot. Therefore the width of one knot is included in the measurement. Although the width of a knot is slight in light webbing it may be a half inch or more in heavy twine. That means that the measurement will vary for each weight of twine and the exact measure of escapement size cannot be defined unless the weight of twine in each case is specified and the width of knot known. The method of measuring center to center of knots has caused confusion. Some California fishermen who overlooked the difference in the two methods of measurement, ordered five-inch heavy webbing for the bag of their trawl nets. This five-inch center to center was only four and a half inches or less inside the knots and after the shrinkage due to tanning, the size inside the knots was about four inches. Subjecting new webbing to a heavy pulling strain will tighten the knots and enlarge the mesh opening. The strain while dragging will both tighten the knots and stretch the twine so that the shrinkage from tanning may be more than offset and in some nets that have been long in use and tanned only once the mesh openings are considerably larger than when the net was new.

The fact that the twine in a net can be stretched has led to complications. For several years the mesh measurement law in California defined how a mesh should be measured. In court cases this led to the pulling of the mesh cords and stretching them so that a single mesh would be enlarged to comply with the minimum size law, in gill nets particularly. The law was therefore amended to provide that mesh size be determined "by taking at least four meshes and measuring them inside the knots while they are simultaneously drawn closely together." This meant that at least four meshes side by side be pulled shut so that stretching the twine would be reduced to a slight amount. This wording of the law was misinterpreted in some cases to mean pulling four meshes end to end. This was an absurdity because four meshes end to end would involve five knots and inside the first to inside the fifth would include three knots in the measurement and would allow the maximum of stretching of the twine. If five meshes were measured, the average would differ from that of a four mesh measurement and likewise for six or seven meshes. In the language of fishermen, this was truly a bastard measurement but fortunately it has been eliminated or nearly so.

This extended discussion of mesh size measurement may seem to be splitting knots needlessly but the fact is that a fraction of an inch in mesh size will make a surprising difference in the escapement of fish through the meshes of a drag net and in the size of fish selected by gilling or wedging in a drift net.

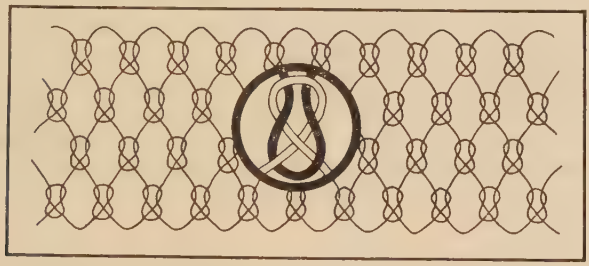

FIGURE 5. Diagram of a narrow strip of webbing, with knots drawn as if loosened. A vertical pull "across the strip" or "with the knots" would tighten the knots

The standard or trawler's knot used in nets is shown in Fig. 5. The enlarged and loosened knot in the center of the drawing illustrates the fact that a pull vertically would tighten the knots. This is what fishermen call a pull "with the knots." A horizontal pull "against the knots" would tend to loosen the knots. Webbing subjected to a continued strain against the knots does not wear so well as if it were hung so that the pull would be with the knots. Machine made webbing is woven in long strips with the knots arranged as in Fig. 5 so that the pull with the knots would be across the strip. This is the reason that fishermen, when making up a net, hang the cut pieces of webbing so that the strain will fall "across the strip," that is, with the knots.

DEVELOPMENT OF TRAWLS

Although trawling originated so long ago that its beginning is lost in antiquity, it is reasonable to suppose that this type of fishing developed

late compared to shoal water fishing with other types of nets which we know to have had a very ancient origin. It is possible that a movable brush weir suggested the beach seine, which in turn may have suggested the trawl. It is not certain, however, that a dredge-like net was not the ancestor of the trawl.

A short beach seine with horizontal pole spreader or "center pole" was used in ancient times and still is fished along parts of our Atlantic coast (crab drags) but this is not, strictly speaking, a trawl or bag net. Adding a deep bunt to such a seine may have suggested a tapering bag and the pole spreader may have become the "beam" for comparatively shoal water fishing. Some such arrangement of beam and bag net, essentially a trawl, was used in England causing a complaint to Parliament in 1376 that certain fishermen had subtly devised a contrivance to which was attached a net of so small a mesh that no manner of fish could escape and that such practice was to the great damage and destruction of the fisheries of the Kingdom. No wonder, for the meshes were "of the length and breadth of two men's thumbs." After the lapse of more than 570 years we still hear the same complaint but in different language, often neither so restrained nor so quaint.

Dredge

Early attempts to drag a bag net in deep water employed a square or oblong frame of poles to which the net was lashed. Rocks attached to the frame kept it on the sea floor. Such a wooden frame was dragged by sailing vessels in England. This process is now employed, especially for shellfish, but the modern frame is of metal and the gear is called a dredge. The bag net of a dredge seldom tapers aft and necessarily is of small size because a large metal frame would require too much power to drag it. Ordinarily the dredge, because of its limited size and shape of the net, is not classed as a trawl. However, it may have suggested the beam trawl which was the ancestral type from which other forms of the trawl developed.

Beam

In a beam trawl each side of the bag mouth was attached to a metal frame ("trawler head") three or four feet high (Fig. 6), mounted on a sled runner (shoe). The two frames were held rigidly apart by a heavy horizontal spar or beam to which the upper portion of the bag mouth (head rope) was lashed. Thus the height of the bag mouth was limited to the height of the trawler heads which supported the beam. This height was not over five feet and generally was only three or four feet. The fishing width or swath was limited by the length of the beam, normally about fifty feet. The length of the net was roughly twice the length of the beam. Beam length varied from thirty to sixty feet and overall net length was seventy to one hundred feet. The foot rope was slack, curving aft a distance about equal to the length of the beam. This distance, formerly called the "bosom" is the amount of "overhang" in more modern terminology. It is the distance that the head rope leads the foot rope. Such an overhang is a characteristic of all types of trawls but is lacking in a dredge where the bag mouth (sides, top and bottom) is attached to a rectangular frame. To permit a deep curve of the foot rope the lower portion (belly) of the net was cut away before the meshes were attached to the foot rope.

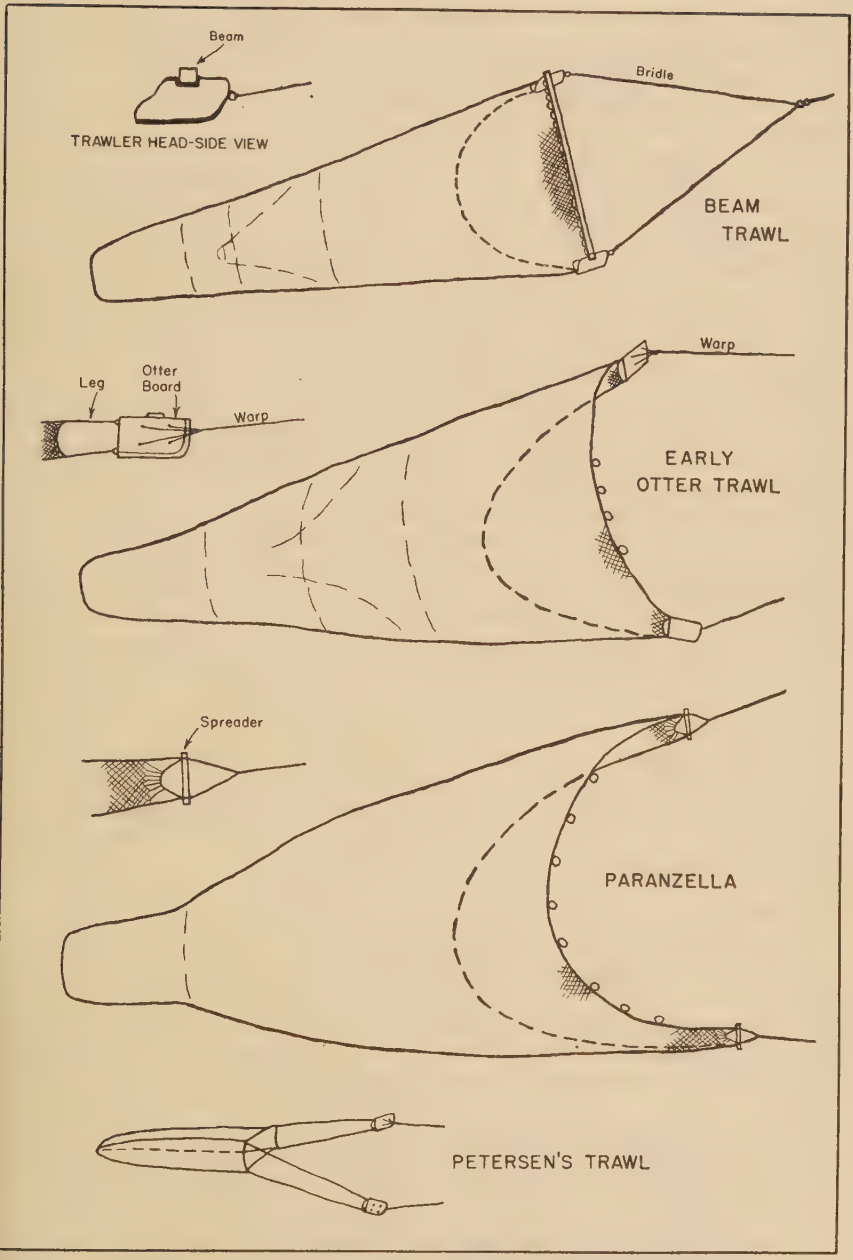

FIGURE 6. Diagram of the beam, otter and paranzella nets

The upper portion of the bag (back or "square") was lashed directly to the beam. The portion of the net aft of the "square," where the bag tapered sharply, often was called "batings," a term seldom heard now. The after end of the net, usually of very small mesh and little or no taper, was called the "cod end," a term still current. This was sometimes laced

with a rope that could be withdrawn easily when the net was to be emptied of its catch or the after edge was closed by a draw rope or "cod line" threaded through small purse rings so that pulling out the rope opened the end of the bag. For this reason the cod end often was called the "purse." Both lacing and pursing of the cod end persist in modern trawls in California.

Early beam trawls had two "curtains," "valves," "pockets," "veils," "flappers," or "funnels" of netting in the last ten or fifteen feet of the taper or "batings" of the net just forward of the cod end, one on each side, to act as fykes or traps to prevent fish escaping by swimming forward faster than the net was being towed. Some such arrangement of fyke trap is still current practice in trawl construction. To save wear on the belly of the net it was often protected by old pieces of netting called a "rubber" or "false belly." Rawhides were used later and some form of "chafing gear" is still common practice in modern trawls. Mesh size in European beam trawls was small. It was larger in the "square" but decreased aft to very small in the cod end, the range being from four or five inches to one and one-half or two inches. Through the years to the present day, this preference for small mesh on the part of trawl fishermen has been the cause of much of their troubles.

Usually beam trawling employed only one tow rope or warp. Two bridles or spans about fifteen fathoms long, one to each trawler head, were shackled together at the forward end for attachment to the warp. Later wire cable replaced rope for warp and bridles, and steam replaced sail. Beam trawling established the still current rule of thumb for the length of warp, a little over three times the sounding of the water depth at the spot being fished.

Much of modern trawler practice originated with beam trawling which continued for many years but was displaced in Europe by the invention of otter boards. This was not true in California because here the "double drag," "two-boat trawl" or "paranzella" preceded the otter trawl and the beam trawl was used but little.

Paranzella

In some of the Mediterranean countries trawling was conducted by two sailing vessels, each towing a warp to one end of the net. The boats traveled parallel to each other but some distance apart so that the diverging warps would keep the mouth of the net spread. Two-vessel dragging was practiced commonly in the areas about Italy, in Holland, and off the Spanish and French coasts. Early Italian bag nets called "tartanas" were towed between two boats. A large French seine called "filet boeuf" was kept open by two boats while dragging (Fish Trades Gazette, 1921). Two-vessel trawling is practiced in the coastal waters of Japan, the more distant grounds being fished by a V-D type of trawl.

The paranzella method had one decided advantage over the beam trawl in that the heavy rope tow lines, in diverging from the net, scraped the bottom for a few fathoms of their length and served to stir up fish from the sea floor. The swath fished by the beam trawl was limited to the beam length but the wing spread of a paranzella net not only was wider than a beam net but the spreading warps tended to increase the fishing swath, thus partially serving the purpose of what much later was called the "ground cable" of the improved V-D type of otter trawl (Fig. 7).

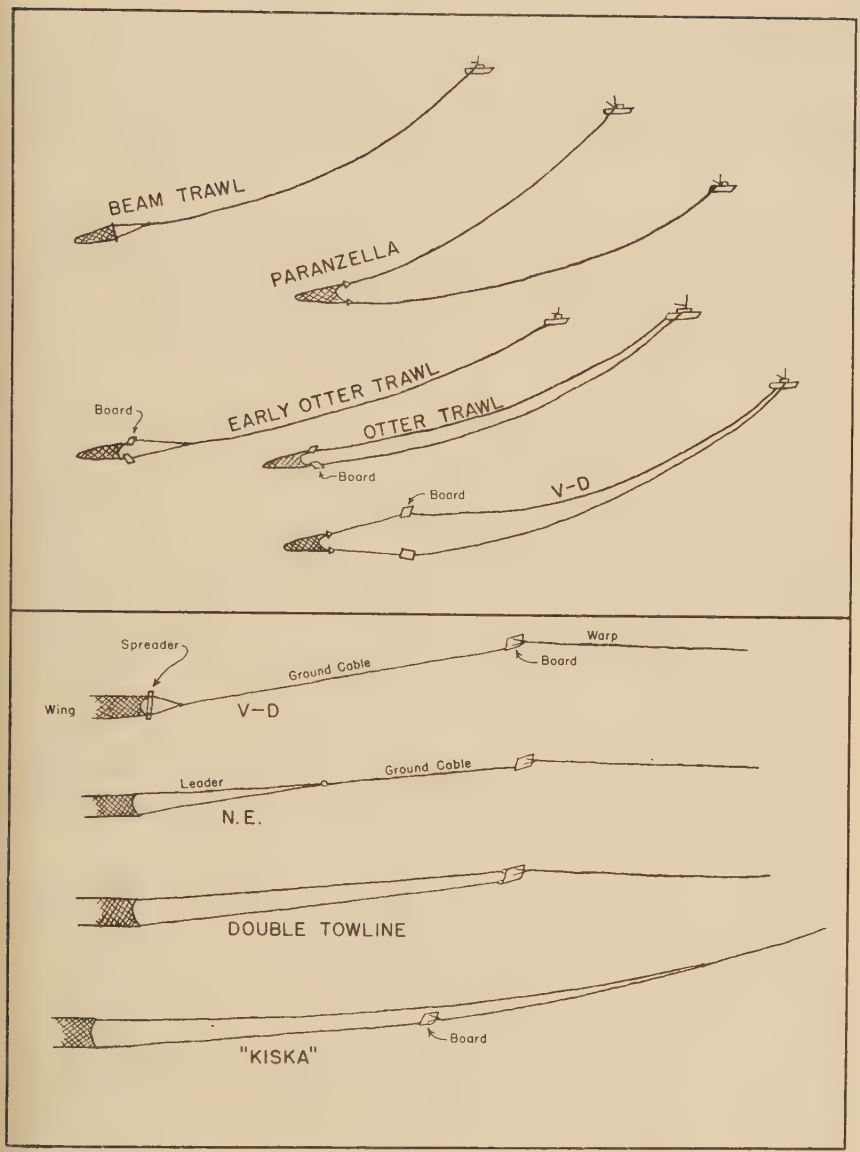

FIGURE 7. Sketch to show beam and paranzella trawls, two forms of early otter trawls, and the improved V-D type. Lower half of the figure illustrates four methods of placing the otter board in advance of the net wing

The paranzella method was introduced in America at San Francisco in 1876. (Jordan, 1887.) It spread to other California ports but was not adopted generally elsewhere in America. Two-boat dragging became the standard trawling method for the next 50 years in California. It was the only method of trawling until about 1919 when otter boards met with a little success. The paranzella "sets" (two boats) were seen commonly up to 2 or 3 years ago. California omitted the beam trawling period as practiced in Europe and on our Atlantic coast.

In California the net is known by the Italian name paranzella. The Spanish name was parega.

The net and its operations in this State will be described later but in general the paranzella was of complex construction, heavy webbing and small mesh and was operated for sole and flounders intended for sale chiefly at San Francisco which long was the flatfish capital of the State.

Otter

The invention of the otter board is credited to English sport fishermen but it is possible that not all of these men were such good sportsmen because some of the earliest records disclose otter boards used by poachers. A Norwegian friend of mine told me how he used an otter board to poach trout in a closed stream. The skiff, with padded oarlocks, moved silently while a light line with two or three baited trout hooks was kept some twenty-five yards to one side and a little behind the skiff by a board, weighted on the bottom to keep it upright. The angle of divergence of the board was maintained by adjusting the three bridle lines which attached the board to the fishing line bearing the hooks. My friend carefully explained that all this was long ago when he was a small boy, from which we may infer that boys in Norway were not very different from other boys. Otter boards were used in England by sportsmen or commercial fishermen possibly as early as 1860. Danish fishermen in the late eighties used otter boards in their plaice seines and a patent was issued in England in 1894 for an improved board with bars instead of chain bridles.

The use of an otter board on each wing of a trawl net gradually spread throughout the world and displaced the beam trawl. The diverging boards opened the mouth of the net wider than could possibly be accomplished by a beam (Fig. 6). Also the freeing of the head rope from its lashing to a rigid spar allowed it to rise higher than the three or four feet of a beam trawl thus increasing the catch by including some of the fishes that rose from the bottom when disturbed by the approaching ground rope.

The otter trawl was introduced into New England in 1905 when the vessel *Spray* was so successful that in the next few years other vessels became otter trawlers. Like the European trawlers, the New England vessels were large steamers which landed the net along side (usually starboard) by the use of a fore gallows and a similar one aft. After 1919 diesel power replaced steam.

The term "beam trawl" had become so well established that it was almost synonymous with "trawl" and many fishermen of Europe and our Atlantic coast persisted in calling their trawl nets "beam trawls" even though the beam had been replaced by otter boards. Unfortunately, the term was not discarded with the beam.

California fishermen were not much impressed by the otter trawl and none was used consistently in this State for about fifteen years after the introduction on our Atlantic coast. European and New England steam trawlers were expensive vessels compared with the paranzella towing tugs, even though two tugs were required. Also the early otter trawl nets fished a narrower swath of the sea bottom than did the paranzella with its flaring warps. Even after the otter trawl had been greatly improved by extending the spread of the boards in the V-D manner (Fig. 7), the two-boat paranzella persisted in California.

By 1930 otter trawls were used extensively on Puget Sound, and in British Columbia they were well established. In the period 1938 to 1940 the V-D type of trawl was being adopted by more and more California fishermen. These were about fifty feet long, which was the same size as the paranzella nets still in use. The otter boards were about 5 feet long, $3\frac{1}{2}$ feet wide and of three-inch iron shod plank. The distinctive feature was a "connecting cable" or ground cable 30 to 100 feet long connecting the board to the wing of the net thus allowing a wider spread of the boards. This was the V-D type of trawl (Fig. 7). Even with this improvement, California fishermen claimed that the paranzella caught twice as much fish but admitted that the cost per pound was less for the otter trawl. In this transitional period some California boats tried otter boards on the wings of a paranzella net so that one vessel did the dragging.

V-D

In the early otter trawl the board was attached directly to the wing of the net. The end of the head rope was made fast to the upper aft corner of the board and the foot rope was attached to the corresponding lower corner of the board. Two Frenchmen, Vigneron and Dahl, invented a trawl for hake fishing in which the net wing was made fast to a short pole, stake, spreader or more properly a brail. (Fig. 7.) The head rope was attached to the upper end of the spreader and the foot rope was made fast to the lower end. Short bridles connected the spreader to a "ground cable" 10 to 30 fathoms (sometimes 50 to 100 fathoms) long, and at the forward end of the cable was placed the otter board. A long bridle, up to 100 fathoms long, from the board was shackled to the opposite board's bridle and in this way only one towing warp was necessary. The ground cable served to stir up fish from the sea bottom and greatly increased the fishing swath of the net. The spreader was usually a 4-inch by 4-inch stake about $3\frac{1}{2}$ feet long and later was called "dhanleno" or "DanLeno." The V-D trawl was used in France before its adoption in England in 1922.

The iron-shod spreader or dhanleno indicated by abrasion on the shoe whether the spreader tipped inward or outward and in this way aided the fishermen to judge whether the relative lengths of head rope and foot rope should be adjusted. The attaching of the head rope to the spreader in the V-D trawl instead of to the otter board did not permit the net to fish much higher than was true with the early form of the otter trawl. The diverging pull of the two boards in either type of net placed a horizontal strain upon the net which was largely born by the head rope and consequently it did not arch up over the mouth of the net no matter how much buoyancy was given it by adding floats (glass balls).

N. E.

The V-D trawl had been in use about a dozen years when in the early thirties some New England experiments with scale models of the V-D trawl operated in clear water demonstrated that the head rope was held down by the horizontal strain on the net and it tended to straighten between the two spreaders. This led to the inventing of a device for removing much of this strain upon the head rope and the result has been called the New England (N. E.) trawl. The spreader was discarded, the net wing was built higher and the short bridles to the ground cable were replaced by long bridles called "leaders." (Fig. 7.) From the after end

of each ground cable one leader was attached to the lower corner of a wing and the foot rope. Another leader was attached to the head rope and upper corner of the net wing. This arrangement permitted the head rope to respond more readily to the water pressure inside the net (under surface of the "square") and resulted in an upward arching of the head ropes and an increased fishing height for the net. The New England trawler fleet has discarded the V-D trawl for the improved N. E. type.

Balloon

The improvement of the N. E. trawl over the former V-D type was chiefly in obtaining a greater fishing height of the gear by higher wings and a more upward arching of the head rope. The next step in this same direction was the construction of the balloon trawl, a light net built to clear the bottom instead of digging in. The earlier trawls were heavily weighted so that the ground line would "bite," that is, would dig into the ocean floor. In the early days this scraping of the bottom was considered necessary in order to capture flatfishes. The balloon net was built so that it would bite as little as possible and only the boards would be in firm contact with the bottom. The foot rope was not weighted. The net was of light webbing and uniform mesh size throughout, usually $4\frac{1}{4}$ or $4\frac{1}{2}$ but a little later it was 5-inch. It was simple in construction, had increased overhang and the mouth opening was built about twice as high as in the otter trawls commonly used along our coast. The head rope ballooned upward to a height of 20 to 25 feet, in contrast to the fishing height of 8 to 15 feet of the ordinary V-D trawls and the six- or eight-foot height of the paranzella nets.

The arching of the head rope in balloon nets was accomplished primarily by the use of two leaders from each wing to each otter board (Fig. 7). These leaders, 16 to 20 fathoms long, were approximately the same length. They were variously called leaders, tow lines and bridles. This use of double leaders accomplishes much the same result as the improved N. E. trawl in which the two leaders from a wing were made fast to the end of a ground cable from the board instead of being attached directly to the board itself. Two warps were used, one to each board.

The balloon net is said to have originated on our Atlantic coast and to have been introduced later in Oregon and Washington. It was first used in California at Eureka in November, 1943, and early in 1944 was in use by more than a dozen of the Eureka trawlers for the taking of rockfishes, known to the fishermen as rock cods. By 1945 many California trawlers were using balloon nets. This high fishing, light net with a boat crew of two men proved itself to be very successful in making large catches of rockfishes at depths of 60 to 80 fathoms and was used for sablefish and sharks down to 125 fathoms.

Kiska

The balloon net was not the last word in the effort to increase fishing height. A west coast device of 1946 went a step farther in elevating the head rope. It also made possible the elimination of floats on the head rope so that the net could be fished at great depths where the water pressure would crush ordinary metal or glass balls. This device has no official name but might be called the kiska after the vessel using it.

In this device (Fig. 7) the ground cable (called "door leg line" or leader) from otter board to net wing is attached only to the lower corner of the net and the foot rope. The head rope is not connected with the otter board but is attached to the towing warp about 50 fathoms in advance of the board by a light $\frac{1}{4}$-inch line (a barrage balloon cable) that is spliced into the warp. (The main warp in this case is $\frac{9}{16}$-inch wire rope.) The net wings are built unusually high. Because the head rope is attached by $\frac{1}{4}$-inch cable so far forward (to the upward sweep of the towing warp) the head rope is able to arch upward to a fishing height of 36 feet off the sea floor. This is a decided contrast to the 4-foot height of the ancestral beam trawl. Because the head rope is elevated by the warp rather than depending upon floats, the depth of water at which this net can be operated is greatly increased and may be limited only by the tensile strength of the warp. At any rate the skipper expects to fish down to 250 or even 300 fathoms, provided catches warrant such deep probing.

1947

Minor variations occur constantly, so much so that it is difficult to find two nets alike but the differences usually do not involve the basic plan of operating the net. The nets now (1947) used by the Italian fishermen are in the process of changing from the heavy, complicated paranzella of past years to the lighter V-D, N. E., or double leader nets of today. Most of the Italian otter board nets retain paranzella characteristics, chief of which are heavy twine, complex hanging, small mesh and wings terminating in spreaders instead of leaders. The Italian nets are used chiefly for flatfishes as in the past and seldom for rockfishes, which in part may justify the retention of the heavier trawls.

A characteristic of California trawling, since the first introduction of trawls on the west coast, has been the landing of the net on the after deck of a comparatively small towing vessel. With but one or two exceptions, California fishermen have not used large vessels with forward set of gallows for landing the net on a forward deck. Trawls in this State are landed directly over the stern or to one side of the after deck.

Trawling gear is by no means stabilized. Its history in Europe and America has been one of change, slowly at first but in later years at an accelerated pace. The first changes were toward increasing the width of the swath of sea bottom covered by the gear but in the last few years there has been a constant effort toward increasing the fishing height of the net so as to capture the fish that were disturbed by the approaching trawl and rose above it before it overtook them.

The Scandinavian fishermen of Northern California, Washington and Oregon are quick to try out any suggestions for improvement of the gear and a successful device is now adopted by most of the trawler fleet within a few months whereas formerly the otter board and V-D improvements were not generally accepted until a dozen years after they had been proven to be successful. In the last few years a large number of young men have entered the west coast fisheries. They are not bound by precedent but are experimenting by trying out changes that occur to them or are suggested to them. A spirit of mutual helpfulness prevails among the younger trawlers which encourages invention and adoption of gear developments.

The most recent development at Eureka occurred during the first four months of 1948. This was the attempt to discover new fishing banks offshore by dragging at depths much greater than was considered practical in past years. Some of these experimental drags were as deep as 220 fathoms and the resulting catches offered encouragement to the continuance of deep water trawling.

THE PARANZELLA

Introduction of the Paranzella

Prior to 1876, fishing in San Francisco Bay was by hand or set lines and beach seining. In that year some San Francisco fishermen secretly had a trawl net made up, drawing upon previous experience in Italy and in secret tried it out in San Francisco Bay with two lateen sailboats, also of the Mediterranean type. The net was very successful in taking a quantity of flatfish at low operating cost. Other fishermen threatened to burn the net and boats used, so that a careful guard over the equipment was necessary for months afterward. The net filled the markets with low cost fish, especially on windy days when other small boats did not fish. By 1880 two trawler companies were operating in San Francisco and by that time the area fished had extended to the grounds outside the Golden Gate and northward toward Point Reyes (Jordan, 1887). Each of the two companies operated three boats, one remaining on the fishing grounds with a three-man crew and the other two boats alternating between dragging and transporting the catch to market. Two lateen sailboats did the dragging. Each company had five or six paranzella nets and each employed about a dozen fishermen. Fishing was in twenty to forty fathoms. Each drag was three to four miles and one drag was made every day except on Thursday when two drags were made for the Friday market. These nets had short wings, a long bag and a total length said to have been fifteen to twenty-five fathoms, but it is doubtful if these early nets, towed by tiny sailboats, could have this length when fishing. Possibly the measurement applied to the nets as stretched for drying. Wing mesh was 1¼ inches, sides of bag three-fourths inch, belly two to four inches and a cod end of very small mesh.

The trawlers remained the objects of bitter hatred by other fishermen because trawl-caught fish had brought down the prices paid. Jordan estimated eighty-five fishing boats at San Francisco in 1880 and that the six paranzella boats landed a greater volume of fish than all the other boats combined.

Paranzella or double dragging expanded to include most of the coastal areas of the State. The net was enlarged, steam and gas engines in tug-like vessels replaced the little sail boats of early days but the large steam trawler ships such as fished the North Sea were not used in California. The vessels employed were small and the net was landed on a roomy after deck. This stern deck landing of the net on a small boat has remained a characteristic of west coast trawling to the present day.

Steam Tugs

In 1885 a larger vessel used steam for trawling at San Francisco. This vessel tried towing two warps attached to outriggers, one on each side of the ship but undoubtedly this lessened the spread of the warps and

reduced the effective fishing swath of the net. Other steam tugs were built a little later for paranzella trawling but they operated in pairs, each towing one warp. By 1888, trawling at San Francisco was by steam. In 1898 two sets (four steam tugs) out of San Francisco were sufficient to flood the market with flatfishes (Clark, 1935). In 1903, each of the two San Francisco companies operated one set with a third boat as carrier to deliver the catch.

Steam tug dragging continued as a characteristic of the San Francisco fishery for about forty-five years. At some time after 1924 and before 1934 the tugs were converted to diesel power, but this only meant installing diesel engines in the same hulls that had served as steamers. The significance of the steam period was that larger vessels with more power led to an increase in the size of the paranzella nets. Also the heavier investment in boat and nets encouraged the domination of the San Francisco fishery by the two or three trawler companies and made it increasingly difficult for an independent fisherman to engage in trawling in "the City." Later he had a chance at other ports when gasoline engines were developed.

Gasoline Boats

In 1909 a pair of boats with gasoline engines entered the San Francisco fishery. They were smaller than the steam tugs and they dragged a smaller net. They fished in "the City" only a couple of years before transferring to Monterey, but they paved the way for a general enlargement of trawling in the State. After the introduction of gasoline engines it was possible for smaller boats to drag without such heavy investment. The nets of these "small outfits" were considerably smaller than those used by the steam tugs. Small boat dragging at once developed in Monterey Bay and out of Santa Barbara, San Pedro and San Diego. Within a few years there were 24 sets in use from Santa Cruz southward. One set operated at Bodega Bay. The southern boats fished chiefly for California halibut, which was not marketed in small sizes so that the destruction of young fish by these small meshed nets was very great. It soon led to such severe legal restrictions that most of the small boats turned to other fisheries. This is another example of the small mesh curse that has plagued trawling throughout its history.

The numerous small boats fishing the new grounds did well at first. By contrast, there were only a couple of steam sets working consistently at San Francisco in 1909. In 1914 the three San Francisco trawler companies each operated only one tug set.

Paranzella Fishery

1915. The fishery at San Francisco in 1915 was conducted by three trawler companies using 75-foot steam tugs, each company operating one set. Occasionally three tugs would tow two paranzella nets, the center boat handling a warp from each net. At Santa Cruz there were four sets in operation. These were smaller gasoline engine boats and smaller nets. The Santa Cruz fish were trucked into "the City" (San Francisco). The three San Francisco sets and the four at Santa Cruz were sufficient to flood the market for flatfishes (Scofield, 1916). Price to the fishermen was 1 to 3 cents per pound. The grounds fished were 25 to 55 fathoms. The San Francisco sets operated chiefly on two banks that had been

heavily fished for years past. One of these banks was four to eight miles southwest of Point Reyes and the other eight miles south of the Lightship off the entrance to the Golden Gate. One-day trips were made. There were usually two drags a day, of 1½ to 2 hours each, either with or against the current. Daily catches averaged 10,000 lbs. per net or about 3,000 lbs. per hour of dragging. Of the catch, 90 percent was flatfishes (locally called soles and sanddabs) of which 20 to 25 percent was discarded as unmarketable. There was no cleaning or icing at sea.

The net then in use was four-inch mesh in the forward part of the bag, smaller in the mid-section and the cod end was 1½-inch of heavy twine. The spread while fishing was estimated at about 50 feet.

The San Pedro-San Diego trawl fishery was eliminated by legislative acts of 1913 and especially 1915 which prohibited dragging in state waters and declared it illegal to possess a trawl net in the area from Santa Barbara County southward. These drastic restrictions were relaxed somewhat two years later but not to the extent of permitting dragging in the southern waters of the State.

1924. By 1924 there were five trawler companies at San Francisco, each operating three steam tugs ranging in length from 59 to 75 feet. The 15 tugs averaged 66 feet in length. Trips were still one day. Drags were 1½ to 2½ hours duration in 30 to 50 fathoms. Catches were still

FIGURE 8. Paranzella trawling at Monterey, December 18, 1927. Warp being hand pulled and rope coiled on starboard after deck. *Photograph by G. R. Chute*

FIGURE 9. Small boat paranzella trawling at Monterey, December 18, 1927. Warp was hand pulled till the net was almost in and then the winch was used. Port warp payed over the side for coiling on the helper boat nearby but not shown. *Photograph by G. R. Chute*

reckoned in "boxes" of 150 lbs. of fish (net weight) to the box. The crew comprised five to seven men on each set, five on the No. 1 boat and two men on the helper boat.

The material used in a typical net was described by Bryce Florence (Pacific Fisherman, 1924) as:

8 lbs. of No. 120 twine
15 lbs. of No. 144 twine
45 lbs. of No. 108 twine
35 lbs. of No. 72 twine
50 lbs. of No. 3½ inch rope
15 lbs. of No. 1½ inch rope cork line
25 lbs. of lead
90 pieces of cork
25 lbs. of 2¼-inch mesh webbing
25 lbs. of 2½-inch mesh webbing
20 lbs. of 3-inch mesh webbing

Most of the net was hand made by the fishermen except for the three body pieces of 2¼-, 2½-, and 3-inch mesh which were machine woven webbing. Materials were tanned cotton twine but manila twine was being given a trial. Depreciation in nets and rope warps was said to be nearly 25 percent per month.

1934. Clark (1935, 1936) published a very comprehensive description of the paranzella net and the California fishery so only a brief summary need be given here for comparison with the present day Italian type of dragnet. In 1934 there were 20 trawlers at San Francisco, seven sets dragging and the remaining boats serving as carriers. All these boats by this time had diesel engines and all were tug-like vessels 56 to 72 feet long. Another fleet of smaller boats fished at Santa Barbara.

Two tugs worked together as a "set." The main boat (Fig. 10) carried the net, received the catch, and towed the starboard warp. This vessel carried a crew of seven or eight men. The helper boat with a crew of three men towed the port warp. The net was landed on the port side of the stern deck of the main boat. Most of the fishing was in 30 to 100 fathoms of water. Boats left port at night, arrived on the fishing grounds at daylight, made three or four drags of 1½ to 2 hours each and returned to port in the late afternoon. Only one-day trips were made so that fish were not cleaned or iced at sea. Operations were carried on in all weather except in bad storms. While dragging, the vessels steered parallel courses, 1,000 to 1,500 feet apart at two to three knots. Standard towing warp was 3¼-inch diameter manila rope and each vessel used 800 to 1,000 fathoms of line in any water depth from 50 to 100 fathoms. This resulted in a ratio of eight or ten to one which is far in excess of the three or four to one ratio which is standard for most trawlers throughout the world. Doubtless this excess of warp permitted more line to drag the bottom and thereby increased the effective fishing swath of the net. The net wings were credited with a spread of 50 to 70 feet while fishing but the head rope cleared the bottom by only three or four feet.

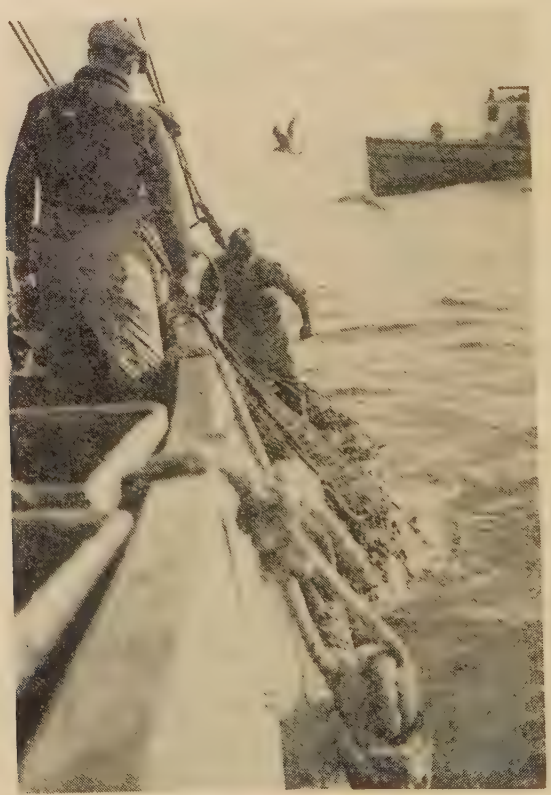

FIGURE 10. Hauling a paranzella net on the port quarter. Helper boat standing by. *Photograph by J. B. Phillips at Point Reyes, January 7, 1932*

The net (Fig. 13) was 75 to 100 feet long with long wings and relatively short throat. The lead line (ground rope) was about 14 fathoms long and the cork line (head rope) was 12 fathoms. The distance of head rope in advance of foot rope (overhang) was only about one fathom. Wing ends terminated in a two-foot wooden spreader which was made fast to a 25-foot "lead" made up of three 3¼-inch ropes lashed together to withstand the abrasion from the sea floor. The manila towing warp was made fast to the 25-foot lead. The head rope carried corks at this time (1934). But a few years later glass balls were substituted. The foot rope carried 12 or 13 one-pound leads along each wing.

A description of a typical net is here summarized in table form to give the names of the pieces of webbing, mesh size in inches, weight of twine as number of threads and length and breadth of each piece in number of meshes.

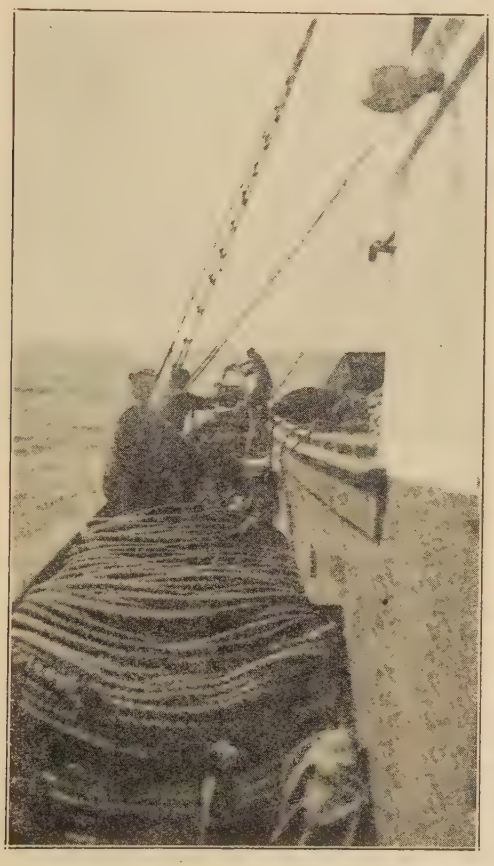

FIGURE 11. A San Francisco trawler. Rope warp being pulled at the stern and coiled on the starboard deck. *Photograph by G. H. Clark, September 27, 1933*

FIGURE 12. Boom hoisting aboard the wings of a paranzella net on a San Francisco trawler. *Photograph by G. H. Clark, June 26, 1934*

Name of pieces	*Italian name*	*Mesh size, inches*	*No. of threads*	*No. meshes long*	*No. meshes wide*
Wing end	Stazzi	4	12	25	75
Wing base	Lati	4	12	100	150
Throat	Manica	2½	9	200	300
Top wedge	Top Scaglielto	4½	42	108	40–20
Bottom wedge	Bottom Scaglielto	8	120	47	30–20
Presack	Connalone	2½	42	50	110
Top of cod end	Sacco	3½	72	60	90
Bottom of cod end	Sacco	3½	84–120	60	90

The top and bottom wedge pieces or scaglieltos are characteristic of the Italian drag nets. They are tapering wedges of webbing of heavy twine extending from the head rope (or foot rope) to the cod end. They take much of the strain while dragging so that rib lines or other fore and aft supports are not used. They are still used in the Italian-style otter trawls of today (1947). The cod end opened across the bottom and

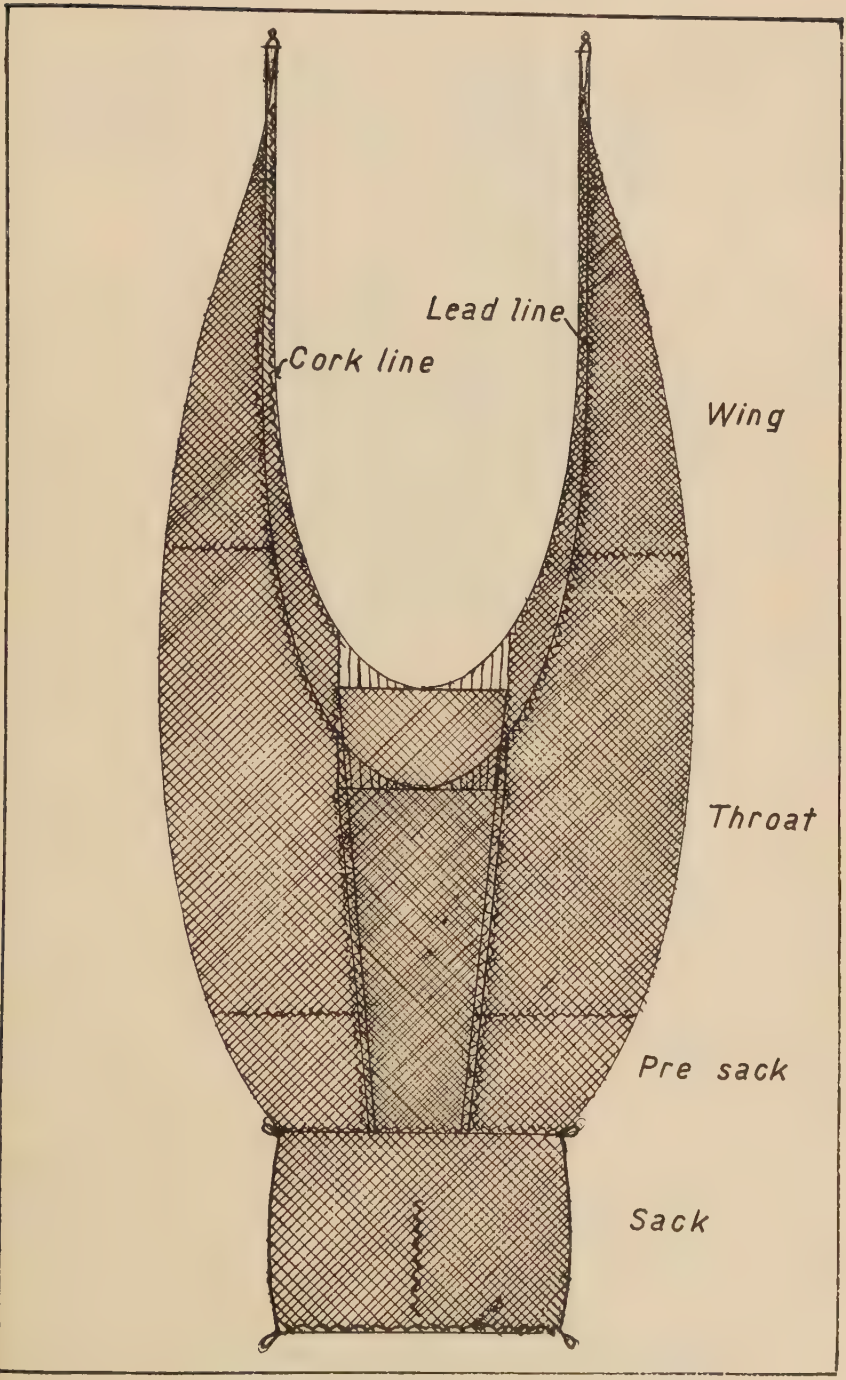

FIGURE 13. A 1934 San Francisco paranzella net laid out on the dock.
Drawing by G. H. Clark

a second opening, laced along the top of the sack permitted brailing out catches that were too heavy to hoist on board.

Four loops of line or ears, one at each corner of the cod end, carried lines (ciuccos) that were lashed to the starboard towing warp while dragging but were used when pulling up the sack at the time the net was landed. The two forward ears are still present in the Italian nets of today and some retain the four ears.

INTRODUCTION OF OTTER TRAWLS

After the introduction of the paranzella net in 1876 there was a period of 42 years (to about 1918) when all trawling in this State was done with the two-boat Italian gear. For an additional period of about twenty years (1918-1938) the paranzella continued to dominate the fishery in spite of the fact that otter board fishing had been successful in Europe at a much earlier date and had been in use in New England since 1905. Trawling in California was a stable fishery for over sixty years (1876-1938), a period characterized by paranzella gear, relatively few boats (four to eight sets) centered in San Francisco and largely influenced by two or three San Francisco wholesale fish companies. There was only small scale dragging south of San Francisco except for a short period at San Pedro and San Diego but this was eliminated by the restrictive legislation of 1913 and 1915. Monterey trawling was always on a small scale. A few sets of double drags operated at Santa Barbara but this port in no way rivaled San Francisco as the center of trawling. The fleet out of San Francisco made occasional trips along the coast from Monterey to Oregon but the catches unloaded at Santa Cruz were trucked to San Francisco and those made on the north coast were shipped by rail or transported by carrier boat to "the City."

About 1929 trawler boats began regular summer fishing off Fort Bragg and Eureka and while they were in the north they delivered their catches at Crescent City, Eureka, Bodega Bay, and Point Reyes. By 1935 it had become customary for most of the San Francisco fleet to fish north of Point Reyes in the summer fair weather (May to October) and make deliveries at Eureka where fish could be shipped out by rail. During the bad weather of the winter months, fishing was mostly south of Point Reyes with deliveries at San Francisco. Gradually boats were spending more and more time at Eureka and fishermen began to look upon that port as their headquarters. Thus in the period, roughly 1935 to 1940, the center of trawling operations shifted from San Francisco to Eureka. The operations were still largely paranzella two-boat dragging.

In 1915, N. B. Scofield, then Chief of the Bureau of Marine Fisheries, urged a trial of otter boards, arguing that one vessel towing an otter trawl might be better than a two-boat drag. Just when the first trial was made is not clear but it must have been about 1917 or 1918; at any rate there was a small amount of otter trawling in Southern California as early as 1918.

In 1918 at San Francisco the 134-foot steam yacht *Ituna* was converted to fishing and was equipped with gallows and boards for otter trawling but she made a poor showing. A few experienced otter trawl fishermen were imported to demonstrate how the net should be handled

FIGURE 14. Loaded cod end of a paranzella trawl hoisted in by boom. *Photograph by J. B. Phillips at Point Reyes, January 7, 1932*

and the catch was increased but the cost was too high. She carried an operating crew of nine men and six fishermen. The large vessel had one advantage, she could fish in weather that kept smaller boats in port.

During the 20-year period 1918 to 1938 otter trawling in California was on a small scale. Usually this fishing was done at one of the lesser ports, possibly because the fishery at San Francisco was dominated by Italian controlled trawler companies. After the shift of trawling from San Francisco to Eureka, the way was open for northern fishermen to enter this fishery and the Scandinavians employed the several forms of otter trawl that were in use in British Columbia, Washington and Oregon.

During this period experimental hauls were made off Long Beach with a small scale otter trawl such as was used for shrimp in Florida. Between December, 1920, and March, 1921, 300 drags were made. It was demonstrated that shrimps were present but not in quantities that would justify commercial dragging.

In the decade 1930-40 the use of otter trawl nets was increasing in Washington and Oregon, especially in the Puget Sound area. One of our California fishermen started dragging in 1937 on Puget Sound and his boat was the twenty-first of the Seattle fleet. The nets used at first were imported from the Atlantic coast. Most nets were of the box type, rectangular in cross section. Some were more complex being made up of an upper and lower half (body and wings) joined along a lateral seam. At that time these more complex nets were not very satisfactory and usually they were modified and rehung by the fishermen.

A scattering few of these northern boats transferred their fishing to California. By 1940 the Washington and Oregon boats made up the bulk of the California fleet, outnumbering the few San Francisco boats then quartered at Eureka. The southward migration of northern trawlers has continued to the present (1947) but not all who came south have remained. Many returned to the north for at least a part of each year.

The significance of this inflow of northern boats was that Atlantic and Puget Sound nets were introduced in Eureka during the last few years of Italian paranzella fishing. These northern nets were by no means standardized. Several modified forms were in use but in general they

FIGURE 15. Balloon otter trawl hoisted to boom-end for drying. *Photograph by J. B. Phillips at Noyo, (Fort Bragg) November 18, 1947*

were two types (box and eastern), which will be described later. These two general types are still in use. During World War II an important modification (the balloon type) was introduced into California. These net forms were in addition to the Italian trawls still used in the State. The result is that at present (1947) there are in California four types of trawls with many modifications. These are the box, eastern, balloon, and Italian. Frequently one boat carries two types of nets and many skippers own a half dozen nets, no two of which are alike. This divergence of gear is characteristic of a transitional period.

Since 1940 the trawl fishery has been anything but stable. It has been characterized by replacement of the paranzella by a variety of types of otter trawls. The tug type of vessel had been overshadowed by such a variety of boats that no one type could be called standard. In general, the vessels have been small and in most cases have been converted from some other type of fishing, such as purse seining or set lining. The fleet out of Eureka was larger than was ever known at San Francisco, numbering as many as 40 boats during the fall and winter season.

ITALIAN NETS

San Francisco 1947

In general appearance the present day Italian otter trawl nets closely resemble the old style paranzella but are of lighter material, a little more simple in construction and somewhat smaller. The long wings terminating in a two foot wooden spreader and the wedge shaped upper and lower scaglieltos or wedges are strongly reminiscent of the old paranzella nets. Most of the Italian fishermen are located at San Francisco. Many of the paranzella tugs are converted to otter trawling (Fig. 2) and fish are landed at the same docks as before so that in outward appearance there is little change from the paranzella dragging of 20 years ago.

The old style paranzella was so long in service that one would expect it to have become fairly well standardized but the present day Italian drag nets show considerable variation in the measurements of the different pieces, in mesh size and weight of webbing. These superficial variations are so general that no two nets are alike. It is probable that these nets are in a transitional stage between the old paranzella and the more modern V-D type trawl. The Italian fishermen, who first accepted the otter board and one boat dragging, did not accept the more modern nets but preferred to use the otter boards on the paranzella nets they had on hand. Few Italians are using the light modern nets even now (1947) and few fish for rockfishes preferring to stay in the flatfish dragging. The low fishing height of their nets practically excludes the Italians from fishing rockfishes. The Italian nets now in use must be classified as otter trawls since they use otter boards in the V-D manner but the nets are in reality the old style paranzella with a few modifications. Because these nets so closely resemble the paranzella, older fishermen along our coast often refer to the Italian boat and gear as a paranzella outfit in spite of the fact that one boat tows the net with otter boards.

A more detailed description of the Italian nets at San Francisco in 1947 may be useful to measure development in gear because it seems probable that these nets are either on their way out or are due for rather drastic alteration in the future.

Few San Francisco fishermen know the English equivalents of the Italian names for the different pieces making up the net so we will arbitrarily assign English names. The characteristic wedge shaped pieces (top and bottom) down the center of the net were called scaglieltos (Clark, 1935) but are now referred to as "skayatas," but no matter, we will call them wedges. The term sack is used for the cod end and for the body of the net back of the wings. To at least some of the fishermen the "wing" extends far back to include what we will call the throat.

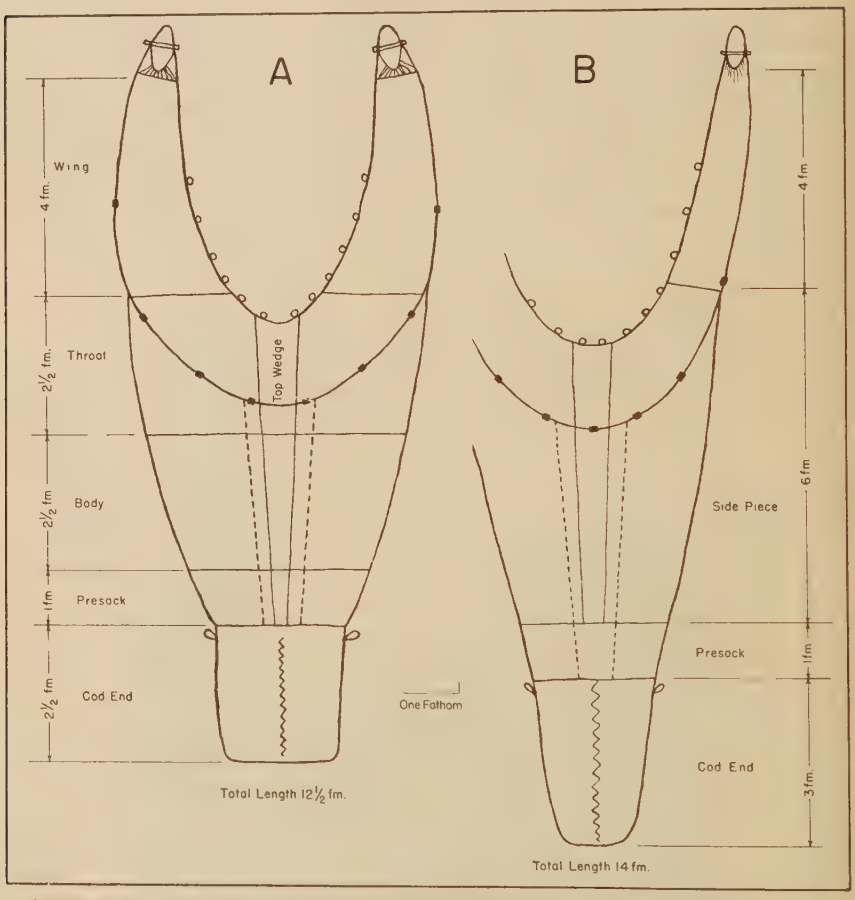

FIGURE 16. Two 1947 Italian nets at San Francisco. They are modified paranzella nets now used for otter trawling

The nets, as stretched normally for drying and mending, measure roughly 12 to 15 fathoms long but overall length depends upon the degree of stretching. Length when fishing is not known but it probably is closer to 8 or 10 fathoms.

A typical net is sketched roughly to scale as net A of Figure 16. Complex selvage strips and lacings are not shown in this outline sketch but they are of importance in that they help to distribute strains and influence the shape of the net when fishing. The over-all length of the net of Figure 16A is roughly 12½ fathoms (75 feet). To simplify the

description we present in table form the pieces of webbing, their length in fathoms, mesh size in inches and size of twine as number of threads.

NET A OF FIGURE 16

Piece	*Length*	*Mesh*	*Threads*
Wing	4	4	9
Throat	2½	2¼	24
Body	2½	2¾	30
Presack	1	3¼	36
Cod end	2½	3-2¾	72-120
Top wedge	6	4½	33
Bottom wedge	4	8	96

In this net the cork line was 2½-inch (circumference) rope 24 fathoms long and carried 12 glass balls five inches in diameter. The lead line was 27 fathoms long, of four-inch (circumference) rope carrying eight lead bands of three-fourths of a pound each. The overhang of the cork line in advance of the lead line was a little less than two fathoms. At the outer end of the wing webbing there was one fathom of heavy lacing before terminating in a two-foot wooden spreader. The top wedge tapered from the cork line five fathoms to the cod end. The bottom wedge of very heavy webbing tapered from the lead line four fathoms to the cod end or from 30 meshes wide to 18 meshes at cod end. The narrower top wedge tapered in the same ratio as the bottom wedge. On each side of both the top and bottom wedges there was a six-inch selvage strip made up of lacing with heavy twine. The purpose of this was to distribute strains as the cod end filled. The wedges take the fore and aft strain instead of the rib lines that are necessary in lighter nets. There was no opening across the lower end of the cod end, only an opening up the back for brailing out the catch. This was laced shut with a light line. A heavy rope bound the lower end of the cod end and extended up the sides to within two feet of the upper end where the rope formed a loop or ear on each side. In the old double drag fishing a line (''ciucco'') ran from the starboard warp almost to the sack where it split into bridles, one to each loop. At present, with otter boards this line, while dragging, is made fast a little way aft of one of the boards. Often English-speaking fishermen call it the ''choo-choo.'' Its purpose is to assist in bringing up the heavily laden cod end when the catch is brought alongside the vessel.

Dimensions and brief description of another net are given to illustrate variations to be found in the Italian nets now (1947) in use at San Francisco. A portion of the net is sketched as net B or Figure 16. This net had an overall length of 14 fathoms (84 feet). There was no separation of throat and body pieces but these were combined as one ''side piece'' six fathoms long and of uniform mesh size. Length in fathoms and mesh size in inches for the different pieces of webbing are given below:

NET B OF FIGURE 16

Piece	*Length*	*Mesh*
Wing	4	3½
Throat and body	6	2½
Presack	1	3¼
Cod end	3	3½
Top wedge	5	3½
Bottom wedge	4	8

The top wedge of this net extended from the cork line only to the presack and not to the cod end. Its taper was from 40 to 20 meshes. The bottom wedge showed no unusual features. It tapered from 35 meshes at the lead line to 20 meshes at the cod end. The bottom surface of the cod end was provided with six ropes running fore and aft from within one fathom of the upper end to the far end of the sack. Apparently these six ropes served as chafing gear as well as carrying the strain on the sack. The cork line of this net carried 14 five-inch glass floats.

Southern California

At the lesser ports of the State there seems to be greater variation in trawler gear (1947). Possibly fishermen on their own, removed from the conservatism of trawler companies, are more willing to try innovations. An example of innovation, especially in Southern California, is the addition of a chain ground line to the foot rope of a net. This chain is often called a "tickler." It is hung four to eight inches below the regular foot rope extending (in the Italian style net) from spreader to spreader. The purpose is to allow the trash that would be picked up by a weighted foot rope to escape through the six-inch gap above the chain. The tickler also saves wear on the foot rope and removes the need for weights on the lead line. At the center of the foot rope, under the throat of the net, there is a tendency for this chain to bite the bottom so that often it is wrapped. Sometimes a couple of fathoms of heavy rope is untwisted to remove one strand and retwisted to include the chain in place of the missing strand. The tickler chain usually is hung to the foot rope every two feet with a six- or eight-inch length of light chain. The tickler is slightly shorter than the foot rope so that it drags a little in advance. The use of a chain tickler was not confined to the Italian type nets. In August, 1945, a light net of the balloon type was observed at Santa Barbara to be equipped with chain tickler and since then various types of trawls with chains have been noticed.

Fishermen explained the use of chain ticklers in the south by the fact that most of the trawling grounds out of San Francisco are mud bottom but that out of Santa Barbara there is shell and gravel bottom requiring heavier gear and more frequent replacement. A foot rope without a chain needs heavy wrapping. The cod end often is provided with chaffing gear, usually a piece of old, heavy webbing to make a "dress" or "apron" called "vesta" by the Italians.

In the south there is a tendency to use larger mesh in trawls because such a large percentage of the catch is California halibut, whereas the San Francisco market demands sole which requires a smaller mesh.

The operations of an experienced Santa Barbara trawler are given here as an example of the Italian type nets used in the southern part of the State. This skipper fished principally for California halibut (1945) and maintained that the Italian type net was better for this kind of fishing but admitted that the new lighter and higher nets were better for other than flatfishes. This boat has fished for halibut in Mexican waters as well as off Santa Barbara and northward. For halibut in California and Mexico the dragging was in 12 to 20 fathoms of water, chiefly in 16 to 18 fathoms. In shallow water the warp used was 50 to 70 fathoms but in deeper water the usual ratio was maintained, that is, three of cable

to one of depth. A four-man crew towing at 2½ miles per hour made drags averaging 1½ hours in duration. The tow was made with two warps, one from each side of the vessel. The warp was one-half-inch (diameter) wire cable but the ground cable or "musetti" from shear board to wing end is four-inch (circumference) manila rope, usually 35 fathoms long but sometimes as much as 50. The boards used were lighter than is usual, five feet long by three feet high, weighing 225 pounds apiece.

The net length was roughly 14 fathoms with an eight-foot overhang of head rope in advance of the foot rope and the fishing height or opening of the throat was three to four feet. In this net one body or side piece represented the throat, body and presack in the San Francisco nets. This eight-fathom body piece extended forward from the cod end into the wing to form a two-fathom base of the wing. The two-fathom base and two fathoms of wing tip made a fishing wing four fathoms in length. The wings were tapered by a take up in meshes at three points along the wing. The wooden spreader was 2½ by 3 inches, 2 feet 3 inches long.

The bottom wedge reached from foot rope to cod end but the top wedge tapered to a point a fathom short of the cod end. Both top and bottom wedges were hand woven but all other pieces were of machine webbing. Length of pieces in fathoms, mesh size in inches and size of twine in number of threads are presented below:

Piece	*Length*	*Mesh*	*Threads*
Wing tip	2	5	27
Body	8	4	27
Cod end	4	5	96
Top wedge	5	4½	60
Bottom wedge	6	6½	72

In this net there were no rib lines for reinforcement. There were three five-inch glass floats on each wing and five along the head rope over the throat. Both head and foot ropes were of the same three-fourth-inch manila line. The foot rope had no leads but carried a chain tickler leaving a four-inch gap between foot rope and chain. The cod end had no laced opening on top but opened across the end by small purse rings and purse line.

Another Santa Barbara net exhibited (1945) some unusual features. This was a 15-fathom net with 3-fathom cod end, 4-fathom wings and 8-fathom body piece except that the body piece (or side piece) was extended to form the entire length of the wing. This piece was four-inch mesh of 27 thread. The cod end was five-inch mesh. Both top and bottom wedges were hand woven and each tapered from 50 meshes to 16. The top wedge of 4½-inch mesh of 60-thread extended from the cork line only half way to the cod end. The bottom wedge of 84-thread 7-inch mesh reached to the cod end.

An unusual feature was the use of a rope tickler instead of chain. The foot rope, to which the webbing was stapled was ¾-inch line. The tickler was very heavy manila rope nearly two inches in diameter and was hung to the foot rope every 3 feet by short chains leaving a four-inch gap between tickler and foot rope. At the center of the throat opening the two ropes were lashed together at six-inch intervals. The tickler carried lead weights, two on each wing and two at the throat. These were homemade lead bands weighing two pounds each. The foot rope carried

no lead. The cork line had four glass balls on each wing and four over the throat. There were no rib lines and the cod end opened across the end by purse rings. Chaffing gear was used under the cod end.

BOX NETS

The box type of trawl, as used on our Atlantic Coast, was introduced to the northwest coast and later brought to California during the period 1935-40. In Washington and Oregon and later in California, modifications in the net were made and at present the box net often is called a western or Pacific trawl. This type is frequently called a four-piece trawl because the body of the net is made with the four parts—a top, bottom, and two side pieces. To this body or box are added wings and a sack or tunnel consisting of intermediate piece and cod end. Size is often designated

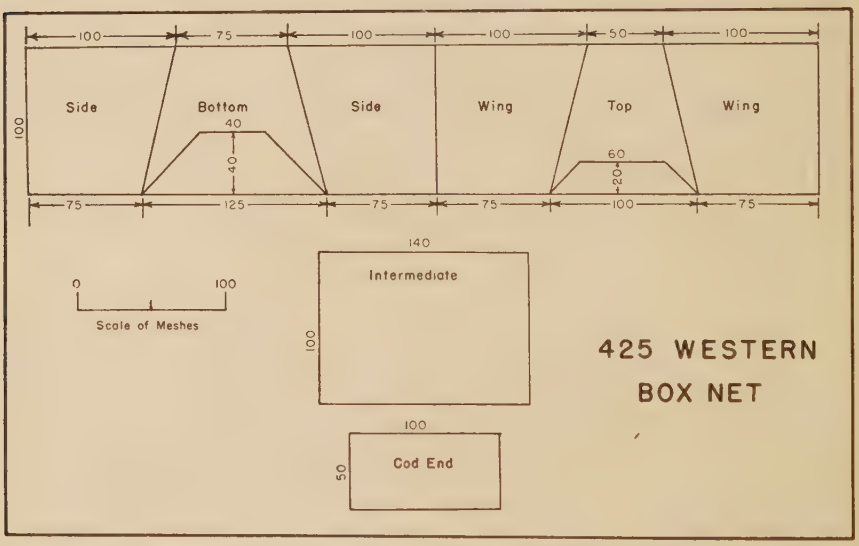

FIGURE 17. Cutting plan for a 425 western box net (425 meshes around the throat). Eureka, May, 1946

by the number of meshes around the throat or forward edge of the body or box. Construction is relatively simple. The body and wings usually are made of the same weight webbing and same mesh size. Frequently the sack is the same mesh size as the box but of heavier twine.

The four body pieces are joined along four seams, each reinforced by a rope rib line. A box results which is rectangular in cross section. A bad rip in the webbing is stopped at one of the four seams by a rib line and is therefore confined to one face of the box rather than running half way round the net. This allows emergency repairs at sea whereas more complex nets must be mended ashore. Hanging is relatively simple and replacement of a piece of web is not too difficult.

The forward edge of the webbing of the bottom piece is cut back before attachment to the lead line. In some of the early box nets there was no cut back of the top piece but its forward edge was lashed directly to the head rope in an attempt to increase the overhang. Present day box nets have a cut back in the top piece, usually about half the depth of the

bottom piece cut back. In general, the box net does not have as much overhang as the so-called eastern type net.

As an example of the earlier box net, the following brief description is given of an Astoria-built net used in California in 1942. It was 400 meshes around the throat with a 96-foot gound line and 80-foot cork line. The top was cut from a piece of webbing 100 by 100 meshes with no cut-back for the cork line. The bottom piece, 100 by 100 meshes, was cutback 30 meshes for the lead line. Side pieces were 100 meshes high, 100 along the top and 125 meshes on the lower edge. Wings were 100 meshes long, 20 meshes at the tip and tapering up to 100 meshes at the wing base. The intermediate piece of heavier twine was 100 by 100 meshes with no taper. The cod end was 60 meshes long by 100 around. This net was used with double tow lines from wing to board for catching flatfishes.

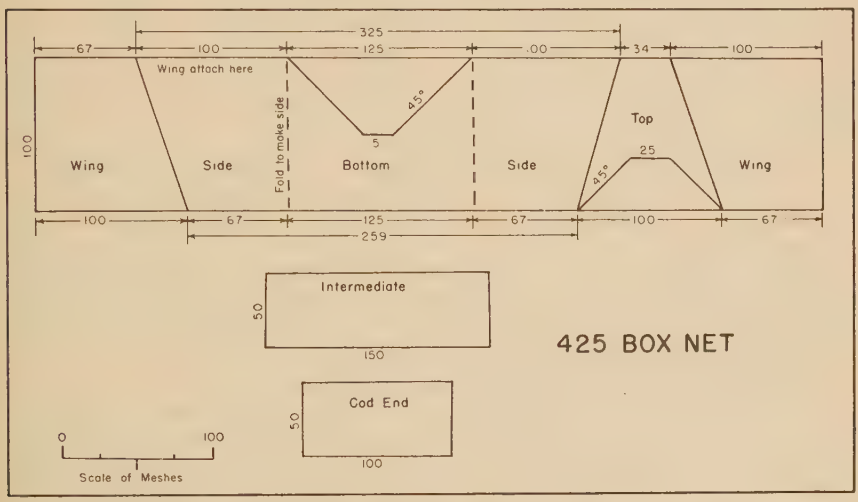

FIGURE 18. Cutting plan of a 425 balloon box net with bottom folded up to make the sides. Eureka, September, 1945

Most of the box nets are now cut out and hung by the fishermen themselves. The men have developed several clever plans for cutting a bolt of webbing into the required pieces with the minimum of waste. (Figs. 17, 18, and 19.) The only meshes discarded are the two cut backs for the lead and cork lines. Two or three net makers cut the top and bottom pieces straight across and add small pieces of webbing to each side of top and bottom pieces so as to avoid any actual cutting back, in which case there is no webbing discarded. The machine woven webbing comes from the factory in a long strip rolled into a bolt. The strip is commonly 100 meshes wide but 50-mesh width may be ordered. Heavy twine webbing, especially for cod ends, is commonly 50 meshes wide. The different plans for cutting out net pieces show variations which are of little consequence except as to the size, proportion, or degree of taper in the resulting net. The cutting plan accounts for the four pieces of the box and the two wing pieces. These six pieces (with a few exceptions) are cut from one bolt so are all of the same mesh size and thread weight. The intermediate pieces are cut from heavier webbing and in nearly all cases the cod end is of extra heavy web. In most of the plans each of the

six pieces (box and wings) is cut out separately but in some plans the bottom piece folds up to make the sides or the top folds down. (Figs. 18 and 19.) This is not important because the edge of the side piece, either fold or seam, is lashed to a rib line.

A typical box net of the type called "western" is diagramed in Fig. 17. This net was examined at Eureka, May 27, 1946. The box and wings were cut from a piece of five-inch webbing 525 meshes long by 100 wide. Dimensions of each piece are shown in the drawing in number of meshes. The forward edge of the top piece (100 meshes) and the bottom piece (125) plus two side pieces (each 100 meshes) totaled 425 meshes at the throat of the box thus designating the net size as a 425 western. The wing base (100) joined the side piece (100) without take up. The wing tapered forward to 75 meshes and the side piece tapered aft to 75 meshes. The aft edge of the box was: bottom piece 75, top 50 and each side piece 75, totaling 275 meshes. The box therefore tapered from 425 to 275 meshes in circumference. The cutback of the top was 20 meshes and of the bottom was 40 meshes to provide for overhang. The intermediate piece was of heavier webbing, 100 meshes long by 140 around and the cod end of still heavier twine was 50 meshes long by 100 around.

In this type of net the taper of the sack commonly is accomplished by a take up of meshes of the box when the intermediate piece is hung. This take up is roughly $1\frac{1}{2}$ to 1 or 2 to 1, that is, one mesh of intermediate is hung to $1\frac{1}{2}$ or 2 meshes of the aft edge of the box. In rare cases the intermediate piece is cut to a moderate diagonal and then hung $1\frac{1}{2}$ to 1 so that the taper of the sack results partly from diagonal cutting and partly from take up in hanging. The cod end of such nets is usually 50 meshes long by 100 meshes around and is hung with a take up of about $1\frac{1}{2}$ to 1 when attached to the intermediate piece.

Another 425 box net, examined at Eureka, September 17, 1945, is diagramed in Fig. 18. Mesh size was five inches throughout the net. This net had a little less taper in the box and the bottom piece was folded up to make the sides without cutting the webbing. The box and wings were cut from a strip of No. 27 thread five-inch webbing 526 meshes long by 100 wide. Wings tapered forward from 100 to 67 meshes instead of to 75 meshes as in Fig. 17. The throat of the box totaled 425 meshes tapering aft to 293 meshes instead of the 275 as in Fig. 17. The intermediate piece was only 50 meshes long and 150 around and made up of No. 48 twine. The cod end was 50 meshes long by 100 around and was made from No. 120 twine. The cod end was both laced for brailing and pursed by 33 rings $2\frac{1}{2}$ inches diameter, a ring hung from every third mesh. The head rope was buoyed by 14 to 17 eight-inch steel ball floats and the foot rope was wrapped cable weighing about 60 pounds dry. In addition to the usual four rib lines, one at each of the four seams of the box, this net carried two additional rib lines. One ran from the center of the head rope, down the center of the back to the far end of the cod end. Another line ran from the center of the lead line along the bottom of the net to the far edge of the cod end.

A larger 525 box net, diagramed in Figure 19 was examined at Eureka September 7, 1947. The larger throat allowed a longer bag made up of two intermediate pieces instead of the usual one. Several nets along the north coast of California were of this type and of similar general proportions but no two were just alike. Most of these nets (1947) were

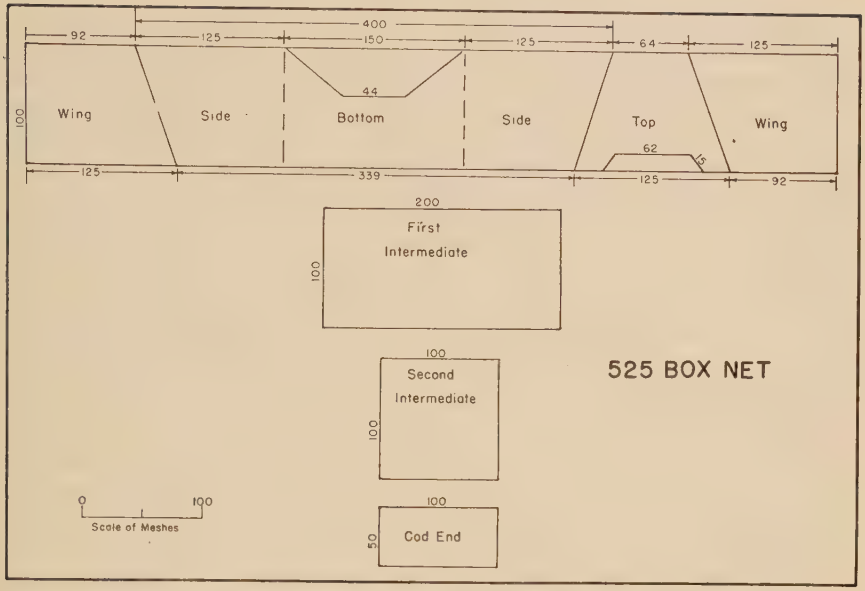

FIGURE 19. Cutting plan for a 525 box net. Eureka, September, 1947

made with five-inch mesh (center to center of knots) throughout the net. Twine size was No. 28 or 32 in the box and wings, 32 or 36 in the first intermediate piece, 42 in the second intermediate and 86 to 120 threads in the cod end. The net of Figure 19 was fished by a three-man crew for rockfishes. The catch was brailed only, so the cod end did not carry purse rings. Warps were pulled by hand (with engines reversed) but the boom with power-pulled line was used to strap in the double tow lines and wings. The box tapered from 525 meshes at the throat to 403 meshes. Each intermediate piece was 100 meshes long. The first intermediate was about 200 meshes around, hung to 403 meshes of the box. The second was about 100 around and was hung to 200 meshes of the first. The cod end was the usual 50 meshes long by 100 around but in this case it was hung without take up, 100 to 100.

EASTERN NETS

The "eastern" type of trawl or "Atlantic" net is said to have been given a trial in our Pacific Northwest a dozen years ago but the fishermen were not satisfied with the nets as then made. Early eastern nets were complicated by many graduations in mesh size, decreasing aft to very small in the cod end. West coast fishermen who were using box nets favored the same sized mesh throughout the net. A uniform taper was considered necessary for the net to open properly while fishing but our fishermen preferred to "take up" or reduce the number of meshes rather than use a net of diminishing mesh sizes. Later, the eastern nets were made with fewer mesh sizes but up to 1946 those made on the Atlantic coast were usually of smaller mesh ($4\frac{1}{4}$- or $4\frac{1}{2}$-inch) instead of the five-inch preferred by most of our fishermen. One or two eastern nets have been made (1947) by California fishermen with a uniform six-inch mesh.

Modified eastern nets became popular in our northwest during the period 1940 to 1943. From there the nets were introduced into California by the southward migration of northwest trawlers. Usually the pieces for these nets were cut out in New England and assembled out here by the fishermen. At present (1947), there are several modifications of the eastern net which were devised by west coast fishermen. Some of the nets still come from New England "knocked down" and some are made up by west coast supply companies. Others are cut out and assembled by the fishermen themselves. There are several variations in the proportions and hanging of both the eastern and box types of net and for want of better names, they are known by the name of the fisherman who first devised or used the modification. We therefore have nets called McCarthy, Stiles, Hamblock and Franklin. Other nets are called Pusti, Pacific Marine, etc., after the name of an eastern or a west coast supply house that made up the net.

The chief characteristic of the eastern type of trawl is that the body and wings are made in upper and lower halves which are joined along the horizontal lateral seam. The principal taper of the net is along this seam instead of along the four seams as in a box net. It is claimed that this construction permits the net to widen or belly out into a better fishing position than can be attained by the box construction. It is admitted that a serious tear in the webbing will run all the way across the eastern net before it reaches a reinforced seam and that emergency repairs are more difficult in this more complex construction. Normally the eastern net has more overhang than the box net. Whatever the merits of the two types, the number of eastern nets in use in California has been on the increase during the last four or five years. In September, 1947, we checked the 18 drag boats then active at Eureka and found that 10 carried an eastern net. To be sure, most of the boats had box nets also. Three or four northern California boats use eastern nets exclusively (1947) but most skippers own five to eight nets and seldom are two alike. A smaller net is often used

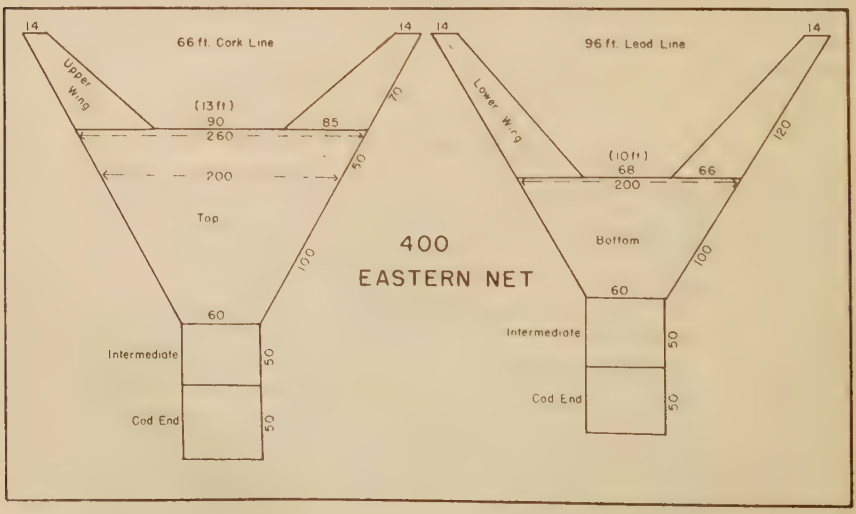

FIGURE 20. Diagram of a 400 eastern net. Eureka, September, 1947. Dimensions are given as number of meshes unless the distance in feet is specified

when prospecting new ground. The type of net and method of towing (double towlines or single ground cable N. E. style) are changed frequently, depending upon the type of fish to be expected in each area.

The characteristic lateral seam of the eastern net is reinforced by a ribline, usually a three-fourth inch diameter rope which runs aft from the wing tip along the seam where the wing halves meet and where the two body pieces are joined. This "ribbing" or "ribbon line" is extended on along the side of the sack to the far end of the cod end. Large eastern nets may have an additional upper and a lower rib line which originate in the aft three or four feet of the body pieces and extend through the intermediate to the far edge of the cod end. In any case the lateral rib line carries most of the strain.

In Figure 20 is shown a diagram of a Stiles eastern net. The size of each piece is given in number of meshes. In this case the wings and body were $4\frac{1}{2}$-inch mesh but the sack was five-inch. This net was reinforced by four rib lines. The wing tip (28 meshes) was over seven feet high and to take full advantage of height the net usually was fished with

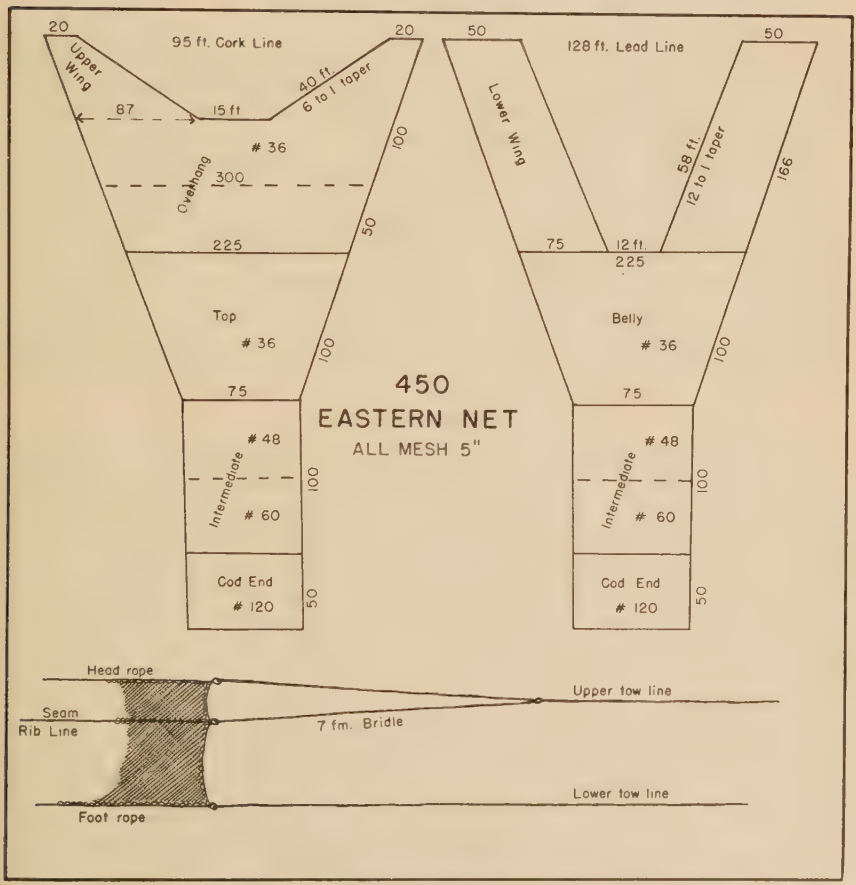

FIGURE 21. Diagram of a 450 eastern net. Dimensions in number of meshes, except along lead and cork lines where distances are given in feet. In this net the upper towline was split into 7-fathom bridles before attachment to the wing end

double towlines for rockfish but it could be fished with a single towline for other fishes. The single towline of 4¼- or 4½-inch (circumference) rope was 60 to 80 fathoms long with a swivel at each end. At the forward end, two-fathom bridles joined the swivel to the door. Bridles to the wing tip were five fathoms but these later (1947) were reduced to three fathoms for convenience in hauling over the cathead. These short bridles to the wing tip represent the V-D type of trawl rather than the N. E. type (Fig. 7).

Figure 21 represents a much larger eastern trawl, a Franklin 450 net, differing in several features from the 400 net of Figure 20. This large net was built to fish high. The wing tip was 70 meshes high (20 plus 50). Mesh size was a uniform five-inch throughout all parts of the net. All portions of the net except the intermediate pieces and cod end were of No. 36 twine. The lower wing half (166 meshes) met the upper half (150 meshes) along the lateral seam thus allowing a little fullness in the lower portion of the wing. The body was cut to a sharp taper and the reduction was continued by the take up of the 125 meshes of the intermediate piece joining 150 meshes of the body.

The 450 net of Figure 21 was used for rockfish and was operated with double towlines (from wing to board) of wire cable 25 fathoms long. The skipper used a western box net with a long single rope tow line for flatfishes. When fishing sole he often used the 25-fathom wire double towlines but added a 60-fathom single rope from the end of the wire to the door (N. E. style). An unusual feature of his double towline operation was the trick of splitting the upper towline into two seven-fathom bridles, the upper bridle to the cork line and the lower bridle to the rib line of the wing's lateral seam (Fig. 21). The rib line at the wing tip was 20 meshes down from the cork line, not at the midpoint of the wing tip. The rib line (supported by the seven-fathom bridle) was the same length as the lead line along the base of the wing. It was claimed that this arrangement encouraged the spreading of the net at the lower portion of the wing.

BALLOON NETS

By balloon is meant a drag net that balloons upward, that is, fishes high off the ocean floor. Strictly speaking, the balloon is not a distinctly new type of net. It is a modification of one or the other of two types. It may be a modified box type or the eastern type, although most of the balloons are box nets and the first balloons introduced into California were of the box type (Figs. 17, 18, and 19). A few eastern type nets have been constructed so that they fish about twice as high as the ordinary eastern trawl and these are called balloon nets or eastern balloons to distinguish them from the western or box type balloon nets.

The idea of a lightly constructed high fishing trawl is said to have originated on our Atlantic Coast. At any rate such nets were in use during World War II in Washington and Oregon. The first balloon net was introduced into California at Eureka in November, 1943, by a trawler from Astoria (Scofield, 1945). In January, 1944, a second boat (from Newport, Oregon) used a balloon and within four or five months more than a dozen Eureka boats were using the new net.

The distinctive feature of the balloon net was the construction. The head rope rose 20 to 25 feet above the ocean floor whereas the ordinary otter trawl fished an 8- to 15-foot vertical opening at the throat and the Italian net fished only six or eight feet high. The original paranzella fished only a four- or five-foot opening. The foot rope of the first balloon nets used in California was not weighted. The head rope was not heavily buoyed but depended upon net construction and long towlines (wing to board) for the high mouth opening. The overhang of balloon nets was somewhat greater than in most otter trawls. The net was of simple construction, made up of light webbing and of the same mesh size throughout the net. In over-all dimensions and in wing spread the balloon was much the same as the other otter trawls used in the State. In order to permit a high fishing head rope, the body of the net was built high with a sharp taper aft. The intermediate piece was not cut to a taper but a moderate taper was accomplished by the take up of meshes in hanging. The base of the wing was necessarily high for attachment at the high throat and was cut to a moderate taper forward to the wing tip but even the wing end was higher than in the ordinary trawl.

The first three or four balloon nets at Eureka (1944) were fished for rockfishes by a two-man crew. After that the crew consisted of three men, sometimes four. Drags were of short duration, commonly one hour. Most of the fishing was 6 to 10 miles offshore in 60 to 80 fathoms. Deeper drags for sablefish were made occasionally. The high wing of the balloon net was connected to the otter board by two long towlines which permitted the head rope to fish high. Most of the 1944 balloons were fitted with "cod catchers" or fykes consisting of a 12-foot curtain of webbing attached to the roof of the intermediate piece and slanting aft and downward to within a foot or so of the floor of the sack. Earlier fykes for holding flatfishes were attached to the floor of the net and slanted upward and aft. Balloons had no specially constructed webbing or selvage for reinforcing the net but depended upon four to six half-inch ropes (laced to the webbing) running fore and aft along the net from cork and lead lines to the cod end. These ropes were called rib lines or seam straps.

During the three years following 1944, the balloon net has been modified only slightly. Some of the nets carry (1947) a few light leads on the foot rope. Webbing is a little heavier and the operating crew includes three men instead of two. Drags tend toward more than one hour in duration. Fykes or cod catchers are omitted from many of the nets. In 1944, mesh size was either $4\frac{1}{4}$ or $4\frac{1}{2}$ inches but by late 1946 and early 1947 most balloons were of five-inch mesh throughout. The double towline system has been retained for rock cod fishing but there is variation in the lengths used. Most skippers agree that longer double towlines, 25 to 30 fathoms or longer, are desirable when after flatfishes. For soles, several skippers prefer a single towline 60 to 80 fathoms long and admit that they learned from the Italians the merits of the long towline in taking flatfishes. Most boats, when fishing rockfishes, use shorter double lines, usually under 25 fathoms and frequently 15 to 18 fathoms. These comments are generalizations which do not cover all cases. The numerous exceptions illustrate the fact that trawling gear and the methods of operating it in this State have by no means reached stability.

In 1944 and 1945 the balloon net was used chiefly for rockfishes with only occasional drags for sablefish and other species. The net proved to

be very successful in taking great quantities of rock fishes and toward the end of the war rockfish fillets were a major part of the fresh fish sales to the western camps of our armed services. Before 1943 the low ceiling price for rockfish had driven our set liners out of this fishery. The balloon net was introduced into this State at a time when the rockfish catch had dropped to a low figure but the use of this net brought about an immediate increase in the total catch. Since 1945 the balloon net has been tried out for other fishes than rockfishes with fair success. Most skippers carry balloon nets for rockfish and ordinary box or eastern nets for all the other trawling. An occasional boat fishes a balloon net for everything, even for flatfishes by the use of long bridles from the wing end to a single ground cable (N. E. style. Fig. 7).

A typical box type balloon net of 1944 was roughly 75 feet long, made from light webbing of 4½-inch mesh throughout. The accompanying table gives lengths in number of meshes and in feet.

1944 BALLOON NET

	Length meshes	*Length feet*	*No. of threads*
Wing	100	25	27
Body	100	25	27
Intermediate piece	50	12½	48
Cod end	50	12½	96

CALIFORNIA BEAM TRAWL

The only beam trawling in California has been in North Bay at San Francisco for shrimps (Bonnot, 1932, and Fry, 1933). This started about 1915 and has been conducted since on a small scale with but few boats. Small troller type gas engine boats 25 to 30 feet long were used with one man fishing alone and pulling the net by hand.

The net used was not the typical beam trawl. It had no trawler heads and the head rope was not lashed to the beam. The 60-foot net had 20-foot wings and the bag tapered to a cod end only one foot in diameter (Fig. 22). The mouth opening was 20 by 2½ feet. The wing terminated in a 2½-foot brail (spreader) with heavy iron shoe which served much the same purpose as the trawler head. Short bridles attached the brail (wing end)

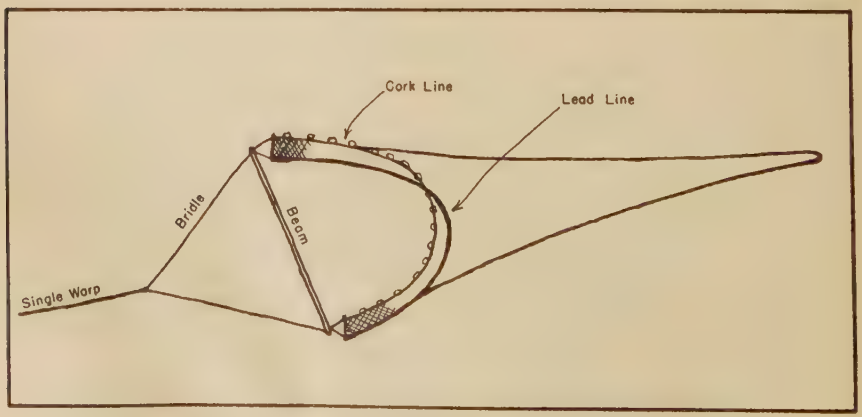

FIGURE 22. Diagram (after Fry) of shrimp beam trawl, 1933

to the end of the beam which was a wooden spar 20 feet long by $2\frac{1}{2}$ inches diameter. A bridle from each end of the beam connected with the single towline (warp). Both head and foot ropes hung slack with an overhang of only 10 inches between the two. The unweighted foot rope was a roll of webbing lashed into a two-inch diameter rope which would not bite into the mud and still hug close enough to pick up shrimps. The head rope carried cork floats. Wing mesh was two-inch, belly $1\frac{3}{4}$-inch and the cod end was one-inch mesh. Old webbing was used as chafing gear.

Drags were made at three miles per hour with the tide, usually one hour duration in one to five fathoms. Two nets were fished alternately. A short boom on the boat was used in lifting the cod end aboard. The grounds fished (1933) were off the Marin County shore near McNears Point.

OPERATIONS IN GENERAL

Warp-depth Ratio

In trawling, the amount of warp payed out is roughly three times the depth of the water being fished but in most cases the length of warp is a little in excess of this three to one ratio. In shoal water, the warp may be five or even as much as eight or ten to one. In very deep drags that ratio is frequently reduced to somewhat less than three to one.

Trips, Ice, Cleaning

In past years trawler trips were for one day with only a few exceptions. Now one-day trips are the exception. Trips are commonly for two or three days and many boats stay out six or eight days. Some skippers plan to make three trips each two weeks or six trips per month. On some of the longer trips Eureka boats scout the coast as far north as Oregon and Washington.

Chipped ice in the hold is not considered necessary for the occasional one day of dragging and many boats do not take ice for the two- and three-day trips. Most trawlers contend that ice is needed for a two-day voyage and on longer trips the catch is nearly always iced down in the hold. Very few boats have refrigeration equipment (1947).

In the past, as at present in this State, there has been no standard practice as to delivering trawl caught fish in the round or cleaned at sea. In the early paranzella fishery there were one day trips and no cleaning of fish aboard. As longer trips were made, cleaning of the species most apt to spoil was initiated but was not widespread and fishermen depended upon taking chipped ice in the hold. Even now the major part, by weight, of the trawl catch is delivered in the round. This is due to the fact that rockfishes are iced and delivered round and they form a high percentage of the catch (1942-47). Other species are usually (not always) cleaned, especially in case the vessel is out more than 48 hours. There are, however, frequent deliveries of flatfishes not cleaned. In general, lingcod, halibut, and sablefish are cleaned at sea. Small lingcod (under six pounds when dressed) commonly are delivered in the round for filleting in the wholesale markets. On the northern grounds small sablefish usually goes overboard as trash but it is more apt to be saved farther south. Cleaning practice changes from time to time, from port to port and even from boat to boat so that generalizations may be misleading. During the war years, 1942-45, there was an acute scarcity of men to clean fish in the wholesale markets and price differentials were offered

fishermen to encourage the cleaning of catches at sea. This gave impetus to the general trend toward increased care in the handling of fish aboard the boats. There remains room for further improvement.

Shooting the Net

When ready to shoot the net the vessel is brought to slow speed ahead. The sack of the net is dumped directly over the stern of the vessel, then the body follows and the wings and towlines are payed out. Many boats have a platform in the stern where the net is stacked and from which the sack and body may be dumped with less effort. The boards may be lifted off by using the boom and when both boards are out, the speed of the vessel is increased somewhat so that the boards will be kept spread properly. Warp is then payed out as the net gradually settles to the bottom while towed at slow speed. The two warps are unwound evenly by keeping watch of the markers on each warp. A common form of marking is to open the strands of the cable and insert a six- or eight-inch strand of cable; two markers (a few inches apart) are placed at each 50-fathom interval and one at the 25-fathom interval.

Hauling the Net

When the drag is completed the engines are stopped or reversed and the two warps are wound in on the drums. The boom is used to hoist the boards into place at the gallows. Frequently, the so-called dandyline rig is used to ease the labor of stowing the boards and at the same time keep the towlines taut. Towlines are wound on the drums, pulled by the cathead and coiled, or are pulled by hand. Rope towlines are more apt to be pulled by hand, especially on small boats, or catheaded in. Cable warps are power pulled by winding on drums.

Landing the Net

Only four or five trawlers in the State (1947) bring the cod end of the net alongside the forward deck, and land the catch there. This is the common practice the world over but not on the Pacific Coast. All our boats, except these four or five, bring the net up to one side or the other of the after deck where the fish are dumped. Practically all the Italian crews bring the net to the port side (Fig. 10). Other crews prefer the starboard side, with three or four exceptions. The catch is hoisted aboard either by brailing or by means of a splitting strap. If other hauls are to be made, the boards are not secured at the gallows and the net is left in the water. After the last drag, the boards are stowed. Usually the wings of the net are stacked in the stern ready for the next layout. The body and sack are piled on the stacked wings. On the last haul the boom is elevated and the sack is hoisted to the top of the boom so that most of the webbing of the net is exposed to the wind for drying. A net hanging from the boom is characteristic of the trawler returning to port (Figs. 3 and 15).

Splitting Strap vs. Brailing

When the trawl is hauled alongside the vessel the cod end, if light enough, may be hoisted by the boom, after which the purse string or trip line is loosened and the fish drop on deck. If the catch is too heavy for this, usually a rope or cable called the splitting strap, is passed around

the cod end and splits the load by pinching off a portion of the catch in the cod end. The other fish are forced forward in the sack of the net when the pinched off portion or "split" is hoisted or "strapped" aboard. The emptied cod end is returned to the water so that another portion of the catch can be pinched off and hoisted. Some large catches require eight or ten splits but the ordinary haul is handled in three to five.

Other fishermen are opposed to the use of a splitting strap, claiming that fish are crushed in the process. Their nets have a cod end laced along the top so it can be opened and the fish dipped or ladled out by use of a long-handled dip net which is usually power operated by a lift line over a cathead. The powered dip net holds 300 to 400 pounds of fish at each lift. This operation is called brailing instead of bailing and we accept the word because it is so universally used by our fishermen. Strictly speaking, a brail is a spreader stick in a net and to brail a net would be to spread or brace it by inserting such a stick. Among California fishermen a brail is a specialized large dip net for unloading fish from net to boat or from the boat's hold to the dock.

Some skippers who brail would not permit the use of a splitting strap and most of the splitters would not brail. Therefore some nets have only a laced cod end opening for brailing and other cod ends have only a purse ring opening along the after edge for splitting. Several middle-of-the-road skippers have provided the cod end with both openings so that either method of emptying can be employed as occasion demands. Rockfish, because of their exposed spines, do not slide back and forth readily in the sack of the net. Some skippers brail catches of rockfish but "strap in" other catches. Another factor is the amount of freeboard aft. The height of the deck above the water in a purse seiner converted to trawling makes brailing a little awkward so such vessels are apt to use a strap.

The splitting strap is sometimes a cable but usually is a rope. It may be free to adjustment as needed or it may encircle the cod end at a fixed distance from the end (usually one-fourth of the way up from the end) by threading the strap through small rings lashed on the cod end.

Size of Catch

A load of 50,000 pounds is considered a very good catch for one of the larger drag boats and most of the fares fall below that figure. A 25,000-pound delivery is considered very successful for one of the smaller vessels. Certain skippers made trips following a schedule, such as a two-day trip twice a week and their boats naturally average much lower per trip than a vessel that stays out three or more days or until a moderately large catch is obtained. From the standpoint of financial return, the catch per month is more significant than the catch per trip. As a gage to abundance of fish, the catch per hour the net fished is of greatest importance.

A few very large catches have been recorded. One such record catch was made at Eureka in the summer of 1945 by a vessel in the medium size class. This catch was 150,000 pounds of rockfish. At least one catch of 130,000 pounds has been reported and several loads have been from 100,000 to 125,000 pounds. Most of these record loads were reported in 1945.

Number of Boats

The number of boats trawling in this State is not stable because so many skippers drag for a period and then go back to their former type of fishing. Boats are constantly moving along the coast so that only a few make one port their year-round headquarters. Some salmon purse seiners and Puget Sound halibut fishermen come down to California and drag during the off season in the north. Many trawlers deserted dragging for the gill netting of sharks while the price was high for shark livers. More recently, the two or three poor seasons so discouraged many sardine purse seiners that they equipped themselves for trawling. Some trawlers even troll locally for salmon or albacore during the height of those seasons although it is hard for them to compete with smaller boats representing less investment. There appears to be a trend in the State toward medium sized general utility fishing boats capable of almost any kind of fishing so that they can turn from one fishery to another as runs of fish and price seem attractive. Large specialized vessels are necessarily less versatile.

The following observations illustrate the change in number of boats dragging at any one time. It was estimated early in 1943 that there were 34 otter trawlers in Northern California but by November of that year a check by the writer showed only 16. These were distributed as follows: 10 at Eureka, four at San Francisco and one each at Point Reyes and Bodega Bay. Some 12 or 14 had deserted to gill netting for sharks. In addition there were three paranzella sets working, one at Eureka and two at San Francisco. Six months later (May, 1944) there were 18 otter trawlers and one paranzella set at Eureka. Subsequent counts of otter trawlers at Eureka were November 1944, 29; December 1944, 22; February 1945, 24; July 1945, 30; September 1945, 24; January 1946, 46; May 1946, 30; January 1947, 32; and July 1947, 30.

During the above period (1944-47) the number of drag boats out of San Francisco varied from one to eight. There were six in February, 1945, and only one in May, 1946. Other boats fished intermittently at several of the lesser ports. One or two boats worked at Bodega Bay and two or three made Noyo (Fort Bragg) their headquarters. In May, 1946, there were five at Noyo. Only an occasional delivery was made at Crescent City or at Point Reyes. Occasionally a boat worked out of Santa Cruz but more frequently at the port of Monterey where there were five in January, 1945, none in July, and seven in March, 1946. One to three boats dragged at Santa Barbara. In October, 1943, there were two trawlers at that port but there were five in July of 1946. One or two boats fished out of Avila (San Luis Obispo County) part of the time.

One paranzella set dragged three or four days in 1945 at Santa Barbara but gave it up as too expensive for the small catches made. The San Francisco and Eureka two-boat paranzellas seem to have given up the ghost late in 1944. During the period 1944-1946 there was some poaching in the closed area of Southern California by two-boat trawling. It is reported that the net used was not a paranzella but was an otter trawl dragged by two boats paranzella style. If the 1945 or 1946 appearance of two-boat dragging proves to be the last, we can credit the paranzella with 70 years (1876-1946) of activity in California.

It is evident from the above that it is misleading to refer to a California fleet of trawlers. Twelve to fifteen boats drag consistently but at

any one time there are (1947) usually about 35 boats dragging, although there is wide variation in this figure. A list of boats made up two months later probably would contain many changes. Referring to potential trawlers is meaningless because so many different types of boats could be used and the conversion is so easily made. A list was made in 1945 to show the boats that had dragged at one time or another during the later part of 1944 and in 1945. This included 148 boats. A similar list for late 1946 and 1947 showed a total of 155 boats but less than a quarter of these boats were trawling at any one time.

Savings Gear

An old California law provided a minimum mesh size of 7½ inches in any net (drag net or paranzella included) used for the purpose of catching salmon, shad, striped bass, or sturgeon. Evidently this applied to the San Francisco Bay area but it did not cover drag nets used for flatfishes and other species.

The early paranzella nets were made with very small sized mesh, especially in the cod end. This later was increased somewhat but in 1933 a check on mesh size showed that cod ends were 3½ inch. This size of mesh retained a high percentage of soles that were too small to be marketed and thereby caused a serious wastage of young fish. A series of experimental hauls with nets of various mesh sizes demonstrated that a minimum of five inches in the cod end permitted the escapment of most of the immature soles while retaining those of marketable size. (Clark and Hatton, 1939). Trawler companies and fishermen cooperated in the construction and trials of paranzella nets of five-inch mesh and it was demonstrated that this larger mesh not only reduced the destruction of small fish but actually increased the catch per drag of the marketable sizes.

As a result of these demonstrations, the trawling industry of Central and Northern California voluntarily agreed in July, 1934 to a five-inch cod end minimum instead of the customary 3½-inch. This agreement held for several years but gradually the older and more conservative net hangers slumped into lifelong habits and mesh size was gradually reduced. There was the fear that too many small flounders or sand dabs were escaping through the larger meshes. A check of mesh size in the modified paranzellas of 1947 showed cod ends to be under four inches in mesh size with 2¾ to 3½ inches the ordinary range. At Eureka and other ports north of San Francisco some of the nets had a mesh size approaching five inches and a good many of the fishermen favored a law requiring a five-inch minimum for trawls.

State legislation of 1947 required a five-inch minimum mesh size for California trawls (except beam trawls for shrimp) effective July 1, 1948. Later (1948) this date was extended to July 1, 1949 for portions of the net other than the cod end, which was to be five inches as of July 1, 1948.

ACCESSORY GEAR

Boards

The otter boards used in California range in size from five feet long by three feet high to seven by four feet. The average size is about five feet ten inches long by three feet four inches high. Thickness varies from two to three inches but most boards are made of two-inch planking with strap iron reinforcements and a heavy iron keel or lead filled pipe

as a shoe. Weight of a single board varies from 200 to 800 pounds but most boards weigh from 450 to 550 lbs. Bridles to the towline (board to wing) are shackled to rings on the outer face of the board near the aft edge. The four bridles (in some cases rods) to the towing warp are fastened on the inner face of the board centering at a point about one-third of the way aft of the leading edge. A few pairs of all-metal boards are in use. All-metal hydroflow boards have been designed to give the maximum divergent pull with the least water resistance but these new boards are not in use in this State (1947).

Gallows

Gallows on trawler vessels are of varied design, from a simple wooden post to elaborate structures of angle steel or metal pipe. No two boats have the same construction of gallows. In general, the top of the gallows is about six feet above the deck or roughly four feet above the two-foot gunwale. Exact height is determined by the width of the otter board to be used and the location of the retaining slot on the vessel's guard rail where the bottom of the board rests when stowed at the gallows. There is some safety device for securing the top of the board against the gallows top. This may be a simple lashing but often is a short chain and hook from the gallows top through a ring, eye or slot on the upper edge of the board.

In practically all cases the gallows are placed at the stern of the vessel, one on the starboard quarter and the other on the port quarter, usually 6 or 8 feet forward of the aft gunwale. The gallows, or at least the fair-leads of the towing warps should be forward of the rudder post, otherwise it would be difficult to maneuver the vessel when the net was in the water. If the pull of the warp was from a point even with or aft of the rudder, the net, not the rudder, would steer the vessel. The gallows are placed on the after deck even in the few cases where the catch is landed on the forward deck. This placing of the set of gallows, one on each aft quarter, is a peculiarity of Pacific coast trawling. In most other trawling regions a set of gallows consists of one forward and one aft with the net hauled amidships and the catch landed on the forward deck. Such vessels usually carry two sets of gallows, one set on each side so that the net may be brought up either to port or to starboard.

Depth Finders, Radio Telephones, Direction Finders

Depth finding instruments have been used in California by the United States Coast and Geodetic Survey for many years and were given a trial on a San Francisco trawler about 1927. By 1937 approximately one quarter of the trawling vessels were equipped with one of the several different types of instruments on the market. By 1947 about 95 percent of the boats were so equipped.

Several of our fishing operations are adjusted to depth of water but with stationary gear, such as set lines, the depth may be determined by a sounding line. A trawl, when fishing, is moving and it is a great advantage to the skipper to know the depth at all stages of the drag, so much so that most captains now say that they would not try to operate without a depth finder. On some trawling grounds it is considered important to recover a bottom sample with the sounding line but this has not been common practice in California.

Gone are the good old days when each secretive captain refused to divulge the locality where he made his catch. Among the trawlers there is now a spirit of mutual helpfulness and a willingness to report to other boats the fishing success while on the grounds. The ship-to-ship radio telephone is used frequently and a skipper hears reports of operations from most of the other boats of the fleet. On the fishing boat frequency there is almost a constant conversation going on between captains and with the markets ashore. Other fishing boat crews listen in to keep posted as to fishing conditions. The ship-to-shore telephone reports keep the market men informed as to what fish can be expected and when. A knowledge of the expected landings by other boats is of considerable interest to each captain but in these days of relatively stable prices, this knowledge is not of the importance it would be if the catches competed in settling the sale price.

Nearly all California trawlers now have radio telephones. Communication by telephone started about 1937 and 10 years ago only a few boats were so equipped. This opportunity to talk with other fishermen while at sea, coupled with the continuous readings of the depth of water under the vessel, have increased the efficiency of trawling and have greatly increased the catching power of each boat as a fishing unit.

Most of the trawlers have a direction finder as an aid to navigation. Radio beacons along the coast are used and the location of radio broadcasting stations are charted so they also may be used in triangulating. Even a beam from one station only is often sufficient to give the location of the vessel when used in connection with depth finder readings compared with charted depths. Direction finders came into use about the same time as depth finders and were in common use before radio telephones were so universally used. No California trawlers of 1947 have radar although two tuna vessels and one purse seiner in Southern California are reported to have installed radar.

Dandyline

When an otter trawl is being hauled up to the boat the warp is power pulled. On some boats the towlines (board to wing) are still pulled by hand, in which case there can be plenty of slack for easy stowing of the boards at the gallows. In most cases towlines are power pulled and it is difficult to stow the boards if they are under strain from the net in the water. For this reason different devices have been employed for holding the net and at the same time introducing slack so the boards could be stowed easily and yet delay as little as possible the power pulling of the towlines. English trawlers used what was called a pennant line. Various devices differ only in nonessential details. The rig used in California is called by the fishermen "dandyline," evidently a corruption of some other name. Originally it was used when nets were dragged on a single towline but it is readily adapted to double lines.

The usual form of dandyline in this State is to hook the board on the warp and attach the towlines to the board by a device that allows the lines to run free of the board when the board is being stowed. The warp terminates in a large swivel, to the lower half of which the two towlines are shackled. The forward bridle chain of the board ends in a large, flattened hook to engage the upper half of the swivel on the end of the warp. Each of the two after bridle chains of the board ends in a ring through which the two towlines are threaded upper and lower respectively. Each

towline is provided with a stopper which engages a ring but will not pass through. Stoppers are placed so that there is some slack in the towline above the ring (Fig. 23). In shooting the gear, after the net is overboard, the towlines are payed out till their stoppers are ready to engage the rings of the board. The hook of the board then is attached to the swivel of the warp and the board is shot. The strain is then from warp, through swivel to board bridle, to board, to rings, to stoppered towlines. In hauling in, on the last drag, the board is brought alongside, engaged by a line from the boom, and hoisted to place at the gallows. The board is unhooked from the warp and the drum continues pulling the towlines which run free through the board rings and are wound on the drum on top of the warp. If another drag is to be made, the boards may be secured alongside without being stowed on the guard at the gallows.

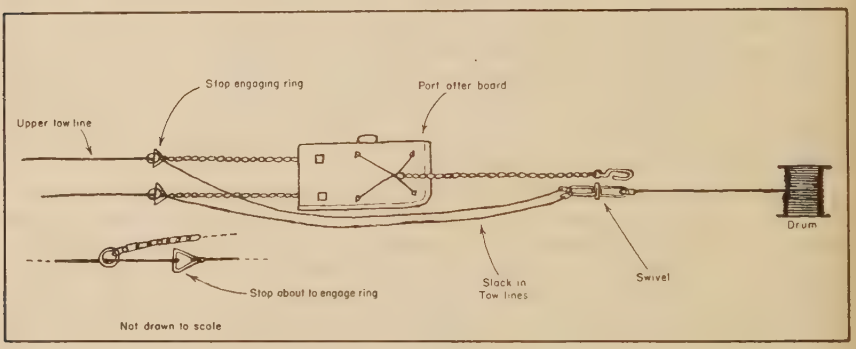

FIGURE 23. Diagram of "dandyline gear"

Choo-choo Line

Italian fishermen use the name ciucco (or ciuccio, which is said to be the Spanish name) but trawlers in general refer only to the choo-choo line. This is a light line running forward from the cod end to be used in hauling in the heavily laden cod end and thus relieve part of the strain on the net webbing when landing the catch. The early paranzella net was provided with four rope loops or "ears" one at each corner of the cod end (Fig. 24). Lines from these ears ran forward and were attached to the starboard warp. Later Italian nets omitted the two after ears (Fig. 16) but retained the two forward loops from which bridle lines ran to the ciucco or choo-choo.

When used on present day box or eastern nets the choo-choo line is much shortened or omitted and attachment forward varies. A frequently used arrangement is a six-fathom choo-choo or one about twice the length of the cod end. The forward end is made fast to an upper rib line of the intermediate piece. The after end frequently terminates in a splitting strap around the cod end. Sometimes the after end is floated by a steel or glass ball.

If the cod end is to be emptied only by brailing or if it is light enough to be hoisted aboard with a boom, then no splitting strap is used and in many cases no choo-choo is needed (Fig. 14). Most nets, however, are rigged with some arrangement of choo-choo to save strain on the net.

Because rockfish, brought up from the depths, are buoyant and float the cod end at the surface, the choo-choo may be pulled by hand to bring

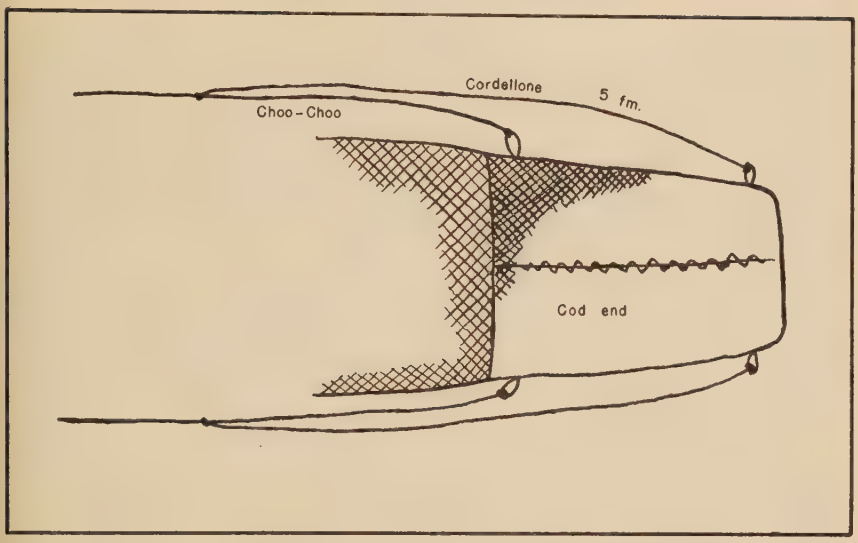

FIGURE 24. Diagram of paranzella net cod end to show attachment of the choo-choo lines

the cod end alongside. Flatfishes and most other species are heavy so that the cod end is hoisted by hauling the choo-choo over a powered cathead.

Haulback Line

When a net with double towlines is hauled and the otter board is in place on the gallows it is sometimes difficult to catch hold of the lower of the two towlines. Recovery of the lower towline is made easier by the use of a haulback or light line $2\frac{1}{2}$ to 3 fathoms long which is attached to the board and the other end threaded through a ring on the upper towline and thence to the lower towline where it is made fast. Pulling on this light line brings the two towlines together and over the gunwale where they can be hauled either by hand or by power as is customary on that particular vessel. This haulback is needed only in case double towlines are used and only a few of the double line boats are equipped with it.

Snag Line

Many of the trawlers in the northern part of the State use (1945) a snag cable or snag line ahead of the net to catch on any obstructions in the path of the net thereby preventing the tearing of the gear. The snag line is especially useful in prospecting new bottom or in dragging grounds where obstructions are known to exist. Each end of the wire cable (usually three-eighths inch) is attached to an otter board on the inner side of the door near the bottom aft corner. In fishing, the line describes an arc several fathoms in advance of the net which permits of stopping the tow (when the line hangs up on a rock) before the net catches. The line dragging in front of the net is said to help in stirring up the fish but it is possible that in some cases this stirring is a disadvantage.

LEGISLATION

The fish and game in any state belong to the people of that state. The management of a fishery is therefore a state, not a federal function and is accomplished through laws passed by the state legislature. The legislature may delegate certain details of management to an appointed commission which may adopt "regulations" which have the force of law. Management of trawling in California has, in the past, been by state law rather than by commission regulations.

Laws may restrict a fishery in one or more of five ways. 1. Gear requirements as to kind, size, construction, mesh size, etc. 2. Closed areas. 3. Closed seasons. 4. Limits as to size or kind of fish taken. 5. Bag limits or amount of fish permitted to a person, or a boat, or a region. Most of the California laws cover the first three restrictions in one statement whereas a limit on size of fish or amount permitted in possession are more specifically covered in separate statements.

In most of the other coastal states the laws prohibit certain gear or methods of taking fish so that anything is legal if not prohibited. A very unusual feature of the California law (passed in 1917) is just the reverse of the above statement. In this State all gear is prohibited except as specifically permitted in the code. This means that in California any gear is illegal unless permitted. This unusual provision in the California law was designed to control new modifications in gear or new combinations in gear and methods of operating until the points in question could be reviewed by the State Legislature. As noted above, the laws usually combine in one statement the three questions of gear, season and area permitted.

The question of ocean fish being caught outside the jurisdiction of a state is of little significance because, no matter where the catch is made, the fish is under the jurisdiction of a state when brought within the boundaries of the state (including inside the three-mile limit). This principle was well established by early decisions of the United States Supreme Court.

In the first stages of trawling in California there was no restrictive legislation, except that an early law governed mesh size (see Savings Gear). The first closed area trawling law was enacted in 1913 because of the destruction of young fish in the southern part of the State. The act of 1913 prohibited trawling in Monterey Bay and in state waters south of Santa Barbara County. The south coast was then designated as District 6 which extended from the south line of Santa Barbara County to the Mexican boundary line. This was at a time when there were many small gas engine boats dragging in the south and enforcement of the closed area after 1913 was difficult.

The 1913 law was amended in 1915 to prohibit the possession of trawl nets in the southern coast area. This area was newly defined as District 19 and included the coast of Santa Barbara County which was not included in the old District 6. Closing a district to the possession of trawl nets practically stopped all dragging in the region, even outside the three-mile limit. The 1915 act went much further and prohibited trawling anywhere in state waters, which meant that all dragging should be outside the three-mile limit anywhere along the California coast. This was based on the theory that dragging closer to shore in

shoal water would result in greater destruction of young fish than fishing far off the shore. This closure of all state waters was in effect only two years.

In 1917 was enacted the general prohibition of all gear unless specifically permitted in the code. The 1917 trawler law permitted dragging in state waters of Districts 5, 6, and 7 (Del Norte and Humboldt Counties) and in District 18 which extended from the mouth of the Carmel River to the south line of San Luis Obispo County. (Santa Barbara County was in District 19, which was closed to dragging and possession of trawls.) A special provision in South San Francisco Bay was made for the taking of shrimp only. The coast from the south line of Humboldt County to the Carmel River and all the coast south of San Luis Obispo County was closed to dragging inside the three-mile limit.

The act of 1919 made only slight modification to permit the taking of shrimp only in both North and South San Francisco Bays and to prohibit dragging in any bays of District 18.

No important change was made in 1921 except that the Mendocino County coastline was included in District 7 which was open to dragging. This northern open area (inside the three-mile limit) therefore extended from the Oregon line to the south line of Mendocino County. District 18 (except bays) was open.

The 1923 law merely added to the area in which possession of trawl nets was prohibited. These additions were the land District 4 (which was Los Angeles County and south to Mexico), Santa Catalina Island and San Diego Bay.

In 1925 there were two changes in district boundary lines, one of which affected dragging. The south boundary of District 18 was changed from the north line of Santa Barbara County to the south line of that county, which transferred the county from District 19 to 18, thereby removing the prohibition against dragging and possession of nets along its coast. Santa Barbara County (inside the three-mile limit) had been closed to dragging since 1915. District 5 was changed somewhat to include the waters of part of Smith River (Del Norte County) and it was no longer open to dragging but this was of small consequence.

There was one change in 1927 that opened Monterey Bay (District 17, Point Santa Cruz to the mouth of Carmel River) to dragging in waters not less than 25 fathoms in depth. A very minor change permitted trawls in District 2 which was a land district of Marin County and northward. To summarize the period 1927 to 1929: Dragging was permitted in state waters from Oregon to the south line of Mendocino County. South of Mendocino County to Point Santa Cruz (Santa Cruz County) was closed out to the three-mile limit. Monterey Bay and south to the Carmel River was open outside the 25-fathom line. From Carmel River to the north line of Ventura County was open and all the coast south of the Ventura County north line was closed to dragging and possession of trawl nets.

In 1929 there was a small change in the boundary between Districts 10 and 17. The south line of the closed District 10 was changed from Point Santa Cruz northward to Pigeon Point Lighthouse (San Mateo County) which slightly enlarged the District 17 open to dragging in not less than 25 fathoms. In 1931 there was no change.

In 1933 dragging inside the three-mile limit was prohibited off the coasts of Del Norte, Humboldt, and Mendocino Counties and this pro-

vision has remained to the present (1947). That meant all the coast north of Pigeon Point was closed to dragging inside the state boundary. South to Carmel River was open up to the 25-fathom line. From Carmel River to Ventura County was open except in bays. Off Ventura County and southward possession of trawls was prohibited. From 1933 to 1947 there was no change in these areas open or closed to trawling.

In July of 1934 the trawling industry of San Francisco voluntarily agreed to a minimum mesh size of five inches in the cod end of trawls. This agreement was in effect for several years.

Another voluntary agreement was made, about 1945, by the trawlers with the fishermen's union for the benefit of the small boat operators. For the area north of Point Reyes, the trawlers agreed to stay outside the 30-fathom line. State law prohibited dragging inside the three-mile limit so this agreement applied, theoretically at least, only where the 30-fathom line extended more than three miles from shore. The 30-fathom agreement was in answer to complaints of set liners and crab trap fishermen that gear was being destroyed by drag nets. The crab fishermen complained also of drag caught crabs entering the markets in competition with their trap catch. The trawlers therefore agreed not to drag for crabs but retained the right to market crabs caught incidentally. This agreement anticipated the 500-pound legal limit of crabs for draggers as enacted in 1947.

The Legislature of 1947 enacted a law prohibiting the use or possession of any trawl (except beam trawl for shrimp) with meshes less than five inches anywhere in the net. (See Savings Gear.) Another act (effective Sept. 19, 1947) prohibited the possession of more than 500 pounds of crabs on a vessel carrying a trawl net.

A minor change in district lines was made (effective Sept. 19, 1947) but this had little effect upon trawling. The north line of District 18 was changed from the mouth of the Carmel River about 4 miles southward to Yankee Point, Carmel Highlands (Monterey County) so as to exclude Point Lobos and the State Park from District 18.

A legislative act of 1911 required fish dealers to keep a record of fish handled and in 1915 monthly reports were required from dealers. A law of 1917 required a receipt be given each fishing boat operator when fish were received, a carbon copy to be retained by the dealer. The 1919 law provided that receipts to fishermen be in triplicate, the third copy to be delivered to the Fish and Game Commission. This law was anticipated and the triplicate receipt system was put into operation in Southern California about July of 1918. This system was started at Monterey about January, 1919, but in San Francisco and northward the triplicate receipts were not required until the law was in effect (about July 1, 1919). The law of 1919 required that the master of any trawler vessel keep a record of the catch by species for each haul and record the duration of the haul. The object was to report trawler catches on the basis of return in fish per hour of dragging. This has been a legal requirement since 1919. The record of each drag was not insisted upon during the period 1919 to 1934 but a daily report of each vessel's catch was required. In 1933 a log book form was drawn up with carbon duplicate pages so that one copy could go to the State as a record of individual hauls. This log book system was installed in January 1934. The form of log has been simplified since but the collection of trawler log records has continued since 1934.

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